Power Engineering

APRIL, 1953

Volume 57, No. 4 Circulation of this issue 30,932

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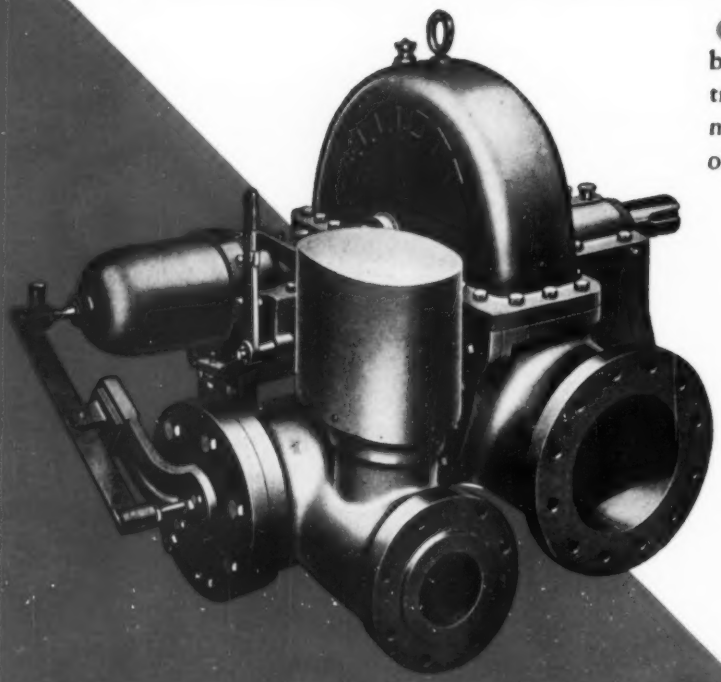
TECHNICAL PUBLISHING COMPANY • CHICAGO, ILLINOIS

Both strong in

YR Turbines

ELLI



YR Turbines are built on a production basis, but engineered to allow an extremely wide range of modifications to meet specific conditions. Here are some of them:

- **Five frame sizes —**
- **Eight different turbine types —**
- **Your choice of several governors each independent of the standard overspeed governor —**
- **Six elective control devices, including:**

1. Two hand valves controlling nozzling
2. Hand-operated speed changer
3. Remote control speed changer, air or electric
4. High exhaust pressure trip
5. Remote control electrical trip
6. Hand throttled emergency trip valve.

- **Gland seal piping for condensing operation, or operation with gas —**
- **Exhaust connection on either side.**

This turbine makes friends everywhere, in all industries, for its tailor-made adaptability, its simplicity, its extremely reliable performance, its surprisingly low maintenance—all qualities of highest value. Capacities to 2000 hp. Speeds, 800-7000 rpm.

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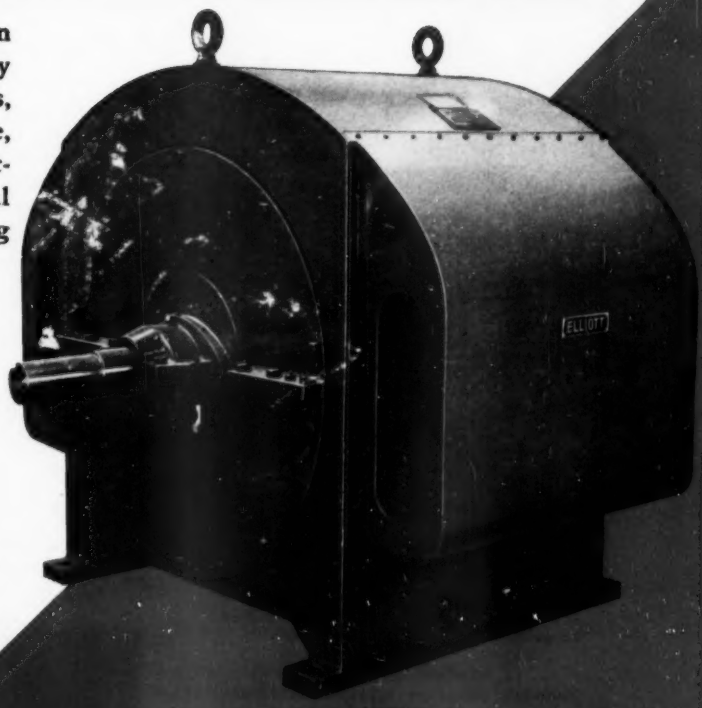
adaptability!

OTT Motors

● **Fabri-steel motors have established an entirely new set of standards in their easy applicability to individual conditions, some of them most difficult. For instance, the standard Elliott squirrel-cage induction motor, without change in electrical design, can be supplied with the following enclosures:**

1. Outdoor splashproof
2. Vertical outdoor splashproof
3. Indoor splashproof
4. Frame modified for top discharge
5. Enclosed self-(base) ventilated
6. Totally enclosed, fan-cooled with top-mounted air-to-air heat exchanger
7. Totally enclosed, water-cooled with side-mounted air-to-water heat exchanger
8. Round frame for mounting inside a duct system with a forced-draft fan impeller mounted on tapered shaft extension.



Above is shown the Elliott splash-proof squirrel-cage induction motor, designed for outdoor service, and proven immune to the effects of rain, sleet, hail, fog, snow, sand, dust and temperature extremes. This motor provides new economy in cost of housing eliminated, and new convenience in locating installations. It requires no special foundation beyond a simple concrete slab. This motor is typical of Elliott advanced thinking in motor engineering.

Get complete data on this and other Elliott motors.

Company

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PRINCIPAL CITIES

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Sunbury Plant of Pennsylvania Power & Light Co., Sunbury, Pa.

Pennsylvania Power & Light Company's

SUNBURY STATION

world's largest anthracite-fired steam electric plant, is "supported" by

GRINNELL HANGERS

Pennsylvania Power & Light Company at its Sunbury Plant faced the problem of providing flexible, but constant support, to main steam piping carrying superheated steam under a pressure of 1350 pounds per square inch, and at a temperature of 950°F.

For "support" on that tough assignment . . . Pennsylvania Power & Light turned to Grinnell. And that is understandable. Grinnell is America's No. 1 supplier of pipe hangers and supports. Grinnell combines modern manufacturing with expert background knowledge gained during a century of piping specialization. Grinnell, and Grinnell alone, can offer these advantages:

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- Practical experience in every type of piping gained during the past 100 years.
- Coast to coast distribution — enabling "out of stock" purchases, anywhere.

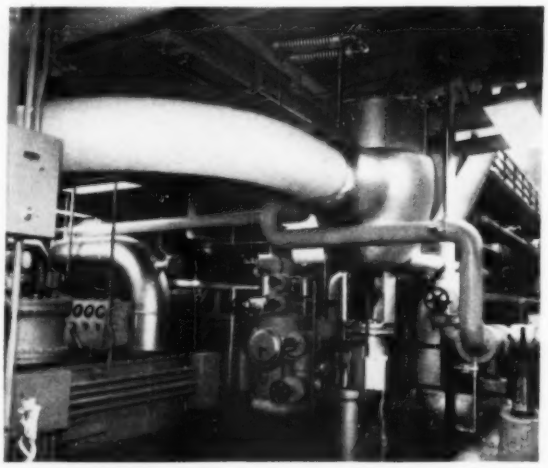
Call on Grinnell . . . "whenever piping is involved."

GRINNELL MODEL L CONSTANT-SUPPORTS maintain full safety factor in high temperature, high pressure systems. 3 physical structures accommodate maximum travel requirements of 2½, 5 and 10 inches; 16 sizes collectively cover numerous load ranges between 141 and 19,530 pounds.

GRINNELL PRE-ENGINEERED SPRING HANGERS — maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes. 16 sizes available from stock — load range from 74 pounds to 9000 pounds.

GRINNELL VIBRATION CONTROL AND SWAY BRACES—dampen vibration, oppose pipe sway and absorb shock. 3 sizes give full deflection forces from 200 to 1800 lbs.; have initial precompressed spring forces from 50 to 450 lbs. respectively.

Twin Grinnell Constant Support Hangers provide uniform lift for steam turbine throttle valve to prevent stresses in piping as it moves from "cold" to "hot" positions.



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APRIL 1953
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Not the proverbial Men from Mars—but just ordinary humans, well-protected by safety clothing, pulling disconnects at a large utility switchyard

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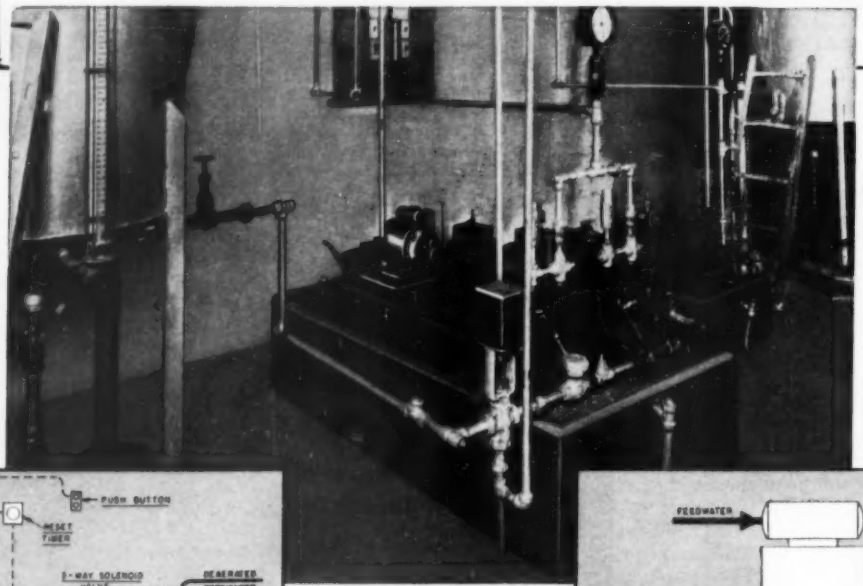
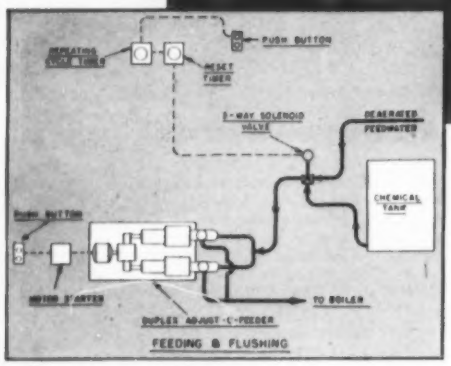
The only magazine devoted exclusively to the job interests of power engineers

Here's the combination

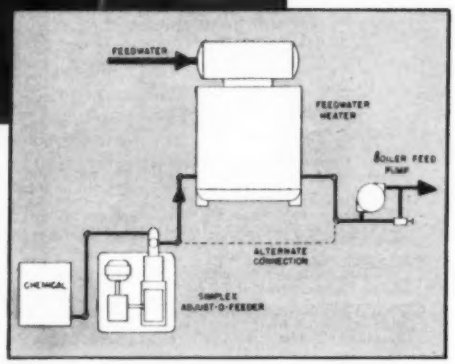
TO TREAT YOUR BOILERS RIGHT





▲ TO PREVENT CORROSION AND SCALE. *Continuous* or *intermittent* phosphate feed direct to the boiler drum.

▲ %PROPORTIONEERS% equipment feeding sodium phosphate and sodium sulphite in the modern power plant of River Raisin Paper Co. at Monroe, Mich. Photo courtesy Pulp & Paper.



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%Proportioneers% Chemical Treating Systems automatically maintain the proper chemical feed for correct boiler water conditions. They reduce boiler maintenance, minimize operator responsibility, and provide positive control of chemical application. We offer standardized equipment and methods for time or flow-responsive control, including chemical feeders, special dissolving tanks, alarm systems, relief valves, automatic feeding and flushing valves, control panels, etc., to maintain top efficiency in power plant operation.

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ENGINEERS' PREVIEW

AN ENTIRELY NEW and highly versatile automatic machine, which will produce a perfect chemical bond between lead and steel, has been announced. In one day, one small machine will clad a steel surface normally requiring 8 to 10 man-days to cover by out-moded hand techniques, according to its originator, Knapp Mills, Inc.

With this new method, the steel is first prepared through leadizing and then lead of any desired thickness can be applied. The lead will not separate from the steel in service unless it is melted off at temperatures close to 621 F, the melting temperature of lead itself.

Such machines will chemically bond a strip of lead up to 12 in. wide by ¼ in. thick to prepared steel. The operator can control the width and thickness of the lead cladding by regulating the speed of the machine and by spreading or narrowing the two cladding heads with which it is equipped.

* * *

WILLIAM G. CHRISTY, until recently Director of New York's Bureau of Smoke Control, has just announced that he has severed his connection with the city and opened an office as consulting engineer at 34 Park Row, New York.

Christy has had many years' experience in air pollution and smoke control work, as well as in power and heating plants. Also he has been active in the ASME for many years and is a past chairman of the fuels division.

* * *

THE TWELFTH generating plant of the Commonwealth Edison-Public Service of Northern Illinois system, to be known as the Will County generating station, will be built on a 216-acre site bordering the Chicago Sanitary and Ship Canal between Lockport and Lemont.

Preliminary excavations and sub-structure work is already well under way for the station building, crib house, water tunnels, barge docks, coal storage yards, electric switchyard and other facilities. It is expected the station will be completed and two new units in service by late 1954.

The new Will County station site is adequate for the development of a one million kilowatt power plant — more than three times the initial capacity to be installed — and the new station and its related facilities are designed to provide for additional generating units.

The property is served by the E. J. & E. Railroad which has connections with all major Chicago area trunk lines and by the Illinois Waterway, over which coal can be barged direct to the site.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS held a conference during the week of March 15, 1953 at the Hotel Sherman, Chicago, Ill. Information significant to engineers concerned with protection of underground cable installations and water handling equipment in steam-electric power plants was included in the four papers given at the Electrical and Communications Symposium held Wednesday, March 18 at the Sherman Hotel, conference headquarters. For additional information contact National Association of Corrosion Engineers, 1060 M & M Building, Houston 2, Texas, A. B. Campbell, Executive Secretary.

* * *

THE SYNCHRONOGRAPH, a repetitive surge generator that makes a simulated bolt of lightning *stand still* so its effects on electric power lines and equipment can be studied, has been developed for experimental use by engineers of the Westinghouse Electric Corporation. It will be of tremendous technical value because it will enable engineers to make almost instantly, calculations that might otherwise have taken weeks. Weighing only about 75 lb, it is conveniently portable.

The synchronograph consists of a repetitive surge generator that simulates a bolt of lightning or surge; a remote receiver that picks up the original surge; and two oscillographs that record the surge at the point of reception.

The repetitive surge generator supplies the simulated lightning wave 60 times a second to the power line or electric equipment under test. The surge thus introduced into the system may amount to only 250 or 300 volts — a relatively small voltage compared to an actual lightning stroke. However, the smaller voltage produces the same kind of wave on the oscillograph as the larger one, and, the effect on the larger voltage can be computed exactly.

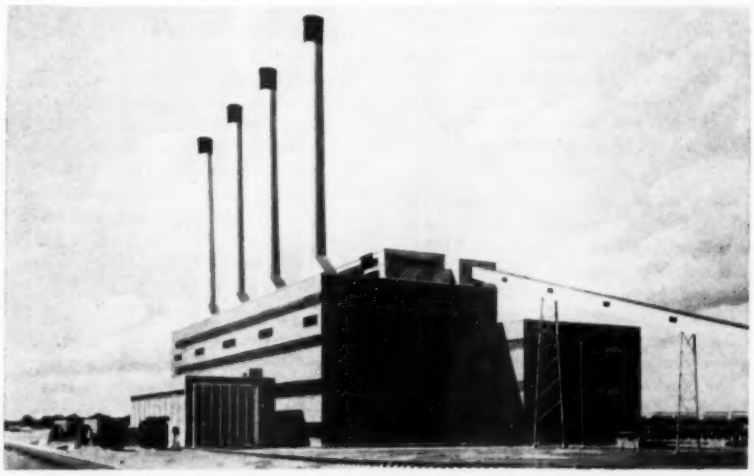
* * *

BECAUSE of the increasing importance of mathematical methods in the field of power engineering, a group devoted exclusively to applied mathematics has been organized under the name of Mathematical Computing Service. It specializes in performing services for industries and universities desiring engineering calculations, charts and nomographs of a high degree of complexity and the treatment of related mathematical problems in the field of power engineering. An important function of this group is the mathematical formulation and complete solution of a problem from given physical data. The staff consists of consultants holding doctorate degrees who are qualified to treat problems in applied mathematics related to the physical sciences. If your power plant organization is interested in using such a service, the Editors will put you in touch with it if you will drop us a line, referring to the Engineers' Preview.

* * *

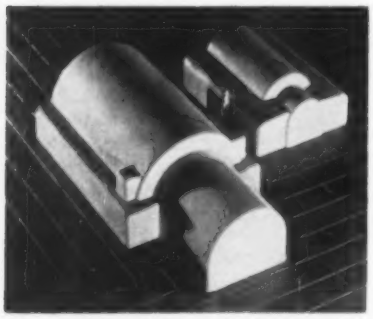
ALLIS-CHALMERS now has under construction its first completely supercharged steam turbine generator. It is shown in the illustration alongside a standard hydrogen cooled machine having the same rating. See next page.

This latest and most important step in the history of size reduction of steam turbine generators is a further development following the first use of supercharged cooling in the rotor of a 60,000-kw Allis-Chalmers generator installed in mid-1951 (POWER ENGINEERING, January 1952).



Artist's sketch of the new Will County generating station to be built between Lockport and Lemont, Ill.

In this newest development in supercharging, cooled hydrogen is forced at high velocity through the conductors of both stator and rotor. Heat removing ability is so effective in this design that generator length and diameter are both cut to the remarkable ratios shown in the picture. Exciter size has also been reduced through the use of an entirely new excitation system.



Scale model (Right) first completely supercharged steam turbine generator now under construction at Allis-Chalmers alongside a model of a standard hydrogen cooled machine having the same rating

The first completely supercharged machine is being built for development and test purposes. It will have a nominal rating of 40,000 kw and a 60,000-kw rating at increased hydrogen pressure.

★ ★ ★

THE WORLD'S FIRST moving rubber sidewalk, a possible solution to the problem of transporting a large number of people at a continuous rate through congested areas, went into operation recently at Chicago's Museum of Science and Industry. More than two million visitors a year will have the opportunity to ride on this first installation.

The moving sidewalk is an example of the many ways in which rubber industry research helps Americans attain a higher standard of living. Although this first moving sidewalk will be used only to transport people through a part of the Museum exhibit, this mode of travel is a practical means of transporting rapidly and efficiently vast numbers of people in crowded areas. Moving sidewalks coupled with escalators may be the answer to the safe and efficient movement of people relatively short distances.

★ ★ ★

AN ELECTRIC RADIANT HEATING PANEL only 1/16-in. thick which can be cemented to the ceiling like wallpaper is United States Rubber Company's newest contribution to space heating. The new panel is a sheet of conductive rubber that is the heating unit, sandwiched between layers of thin plastic and aluminum foil.

The panels are called Uskon, and are extremely light, weighing only six ounces per square foot. They are bonded to ceilings of plaster, sheetrock or similar smooth material by means of a special adhesive. Occasionally, molding is used in conjunction with the adhesive. The number of panels required is determined by climate, insulation, and other factors, but generally, Uskon does not cover the entire ceiling.

Where electricity is available for 1½ cents a kilowatt hour or less, the cost of operation is comparable with that of other fuels.

★ ★ ★

TWENTY HIGH SCHOOL GRADUATES a semester are now eligible for college educations without out-of-pocket expense. That was the high point of an unusual co-operative scholarship plan announced recently at Armour Research Foundation of Illinois Institute of Technology.

Dr. C. E. Barthel, Jr., assistant director, explained 10 students will be eligible in Metallurgical Engineering and another 10 in Mechanical Engineering. He said the Foundation will: Pay the student's tuition for a degree at Illinois Institute of Technology; Pay the student a $90 monthly stipend 12 months a year to start with; Employ him in its laboratories to work with some of the world's leading engineers and scientists.

★ ★ ★

DR. R. C. ULMER, for the last seven years technical director of E. F. Drew & Co., has joined the Engineering Department of Combustion Engineering Super-

heater, Inc., New York, where he will be engaged in development work.

A graduate of Ohio State University, from which he later acquired his doctorate, Dr. Ulmer spent some years as a chemist in the Research Department of The Detroit Edison Company where he was associated with many power plant operating problems. He has written many technical papers and articles and holds membership in the ASME, ACS, ASTM, AWWA, and NAPE.

★ ★ ★

GENERAL ELECTRIC COMPANY will manufacture the first large generator with liquid-cooled conductors in the history of the electrical industry.

A new method of circulating a liquid through hollow conductors will be used in the stator of a turbine-generator set for the new Eastlake power plant of the Cleveland Electric Illuminating Company.

The unit, consisting of a tandem-compound turbine rated at 208,000 kw and a generator rated at 260,000 kva, will be one of the largest in the world. This generator, alone, will be capable of supplying the household electrical needs of 600,000 people.

The liquid cooling method makes possible the design and manufacture of generator armatures having much higher capability than present units.

Other technical features of the Cleveland machine include direct cooling of the rotating field winding with hydrogen, a new and improved grain-oriented strip steel in the magnetic portion of the armature, and an improved type of insulation.

★ ★ ★

FOUR MOTORS — two, the largest ever built — for installation in the U. S. Air Force's transonic and supersonic wind tunnels at the Arnold Engineering Development Center at Tullahoma, Tenn., are nearing completion at the East Pittsburgh, Pa., plant of the Westinghouse Electric Corp.

The motors — two rated at 83,000 hp each and two rated at 25,000 hp each — will be installed in tandem fashion. The 83,000-hp motors will stand 21½ ft high and weigh 225 tons. Their 122-ton rotors will turn at 600 rpm.

In addition to the 216,000-hp four-motor drive, the rotating machine will have five compressors, now under construction at the Westinghouse plant in Sunnyvale, Calif.

The blades for the compressors measure two feet across the face, are six feet long, and will be mounted on a spindle 18 ft in diameter. Weighing almost two-thirds of a ton each, the blades will be solid forgings.

Although the 83,000-hp motors have the highest stored energy of any rotating mass ever built, they can be brought to a halt in about three minutes by using their wound-rotor motors as brakes, the energy being dissipated in liquid rheostats.

★ ★ ★

DR. JOHN V. N. GRANGER, assistant chairman of Stanford Research Institutes Engineering Department and head of its Aircraft Radiation Systems Laboratory has been honored by the Eta Kappa Nu Association as its choice of *The Outstanding Young Electrical Engineer of 1952*.

Presented each year since 1936 by this Association, national honor society of electrical engineers, the award is based upon service to the community as well as professional achievement. The recipient must be no older than thirty-five and must have graduated from a regular electrical engineering course not more than ten years before being nominated.

Fig. 6003 W. E. 600-pound Cast Steel O. S. & Y. Gate Valve with welding ends.

The name "POWELL" on a valve assures absolute dependability

Naturally, in buying a valve, the first consideration is its ability to perform a specific service. But that is not all. For it must also be a valve that will continue to function dependably for a long time. Powell Valves have an established reputation for this dependability.

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Cincinnati 22, Ohio

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DEPENDABLE VALVES SINCE 1846

BRONZE, IRON, STEEL AND CORROSION-RESISTING VALVES

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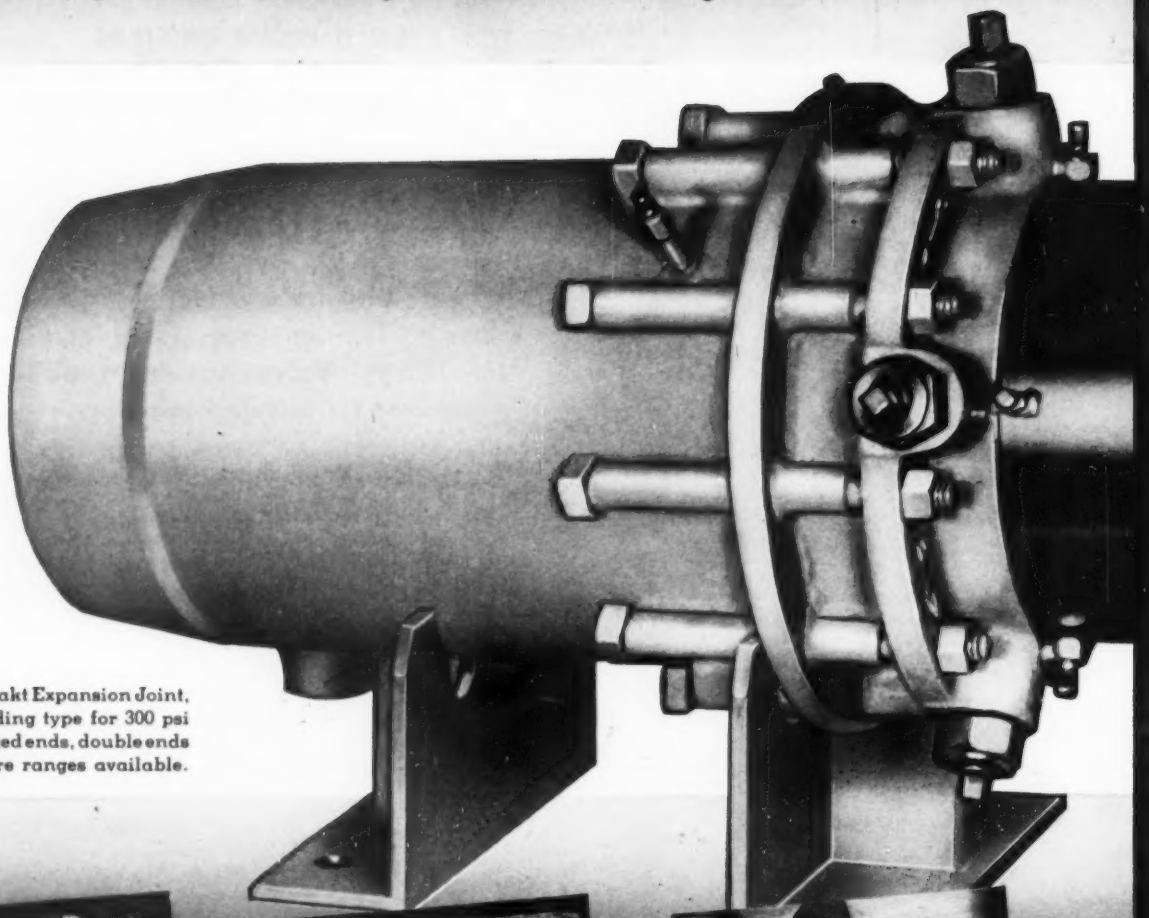
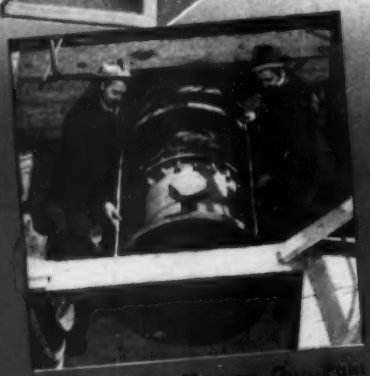
PHILADELPHIA ELECTRIC
GUN-PAKT EXPANSION JOINTS for



Yarway Gun-Pakt Expansion Joint, single end welding type for 300 psi pressure. Flanged ends, double ends and all pressure ranges available.

Boring body of 24" Gun-Pakt Joint for Philadelphia Electric Co. in Yarway factory.

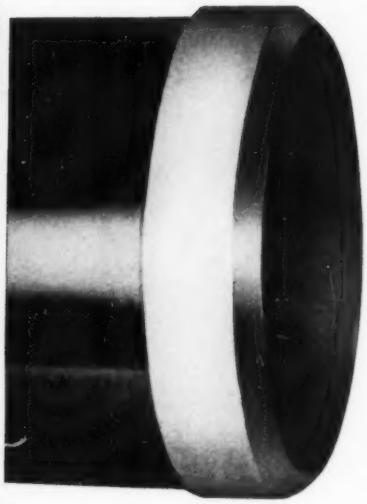


Installing 24" Yarway Gun-Pakt Joint in Philadelphia Electric underground steam line.

Adding packing to Yarway Gun-Pakt Joint in P.E. manhole.

YARWAY®

relies on 24" UNDERGROUND STEAM LINE



Philadelphia Electric Co. is one of many utilities, institutions and industrial plants who rely on Yarway Gun-Pakt Expansion Joints for steam distribution lines. As an example, twenty-four large 24" Gun-Pakt Joints are helping maintain PE's reputation for reliability, on their new 24" steam distribution line. Gun-Pakt Joints frequently are selected because of the following features.

- **HIGH FACTOR OF SAFETY.** Gun-Pakt Joints are rugged joints—strong and dependable.
- **LOW MAINTENANCE.** No need for shutdowns, because Gun-Pakt Joints are *serviced under full steam pressure.*
- **FEWER JOINTS NEEDED.** Each sliding sleeve may have a 4", 8", or 12" traverse—maximum expansion 24" for a double-end joint. Fewer needed in given length of line.

For the full story on these and other Gun-Pakt Expansion Joint features (like service outlets right on the joint) write for Yarway Catalog EJ-1912.

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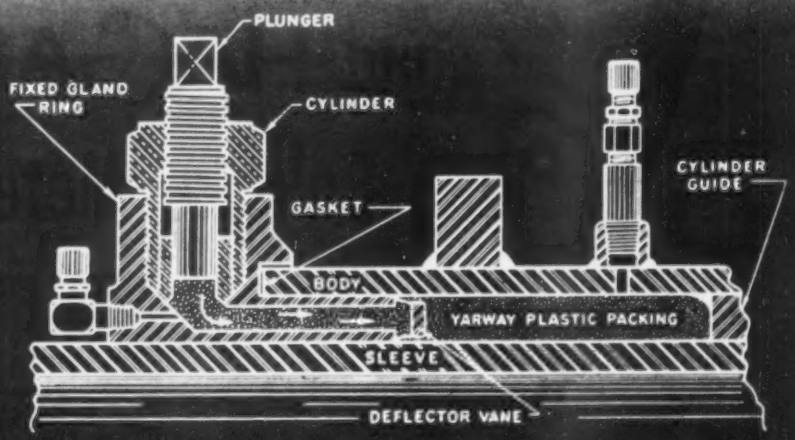
114 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities



CROSS SECTION OF GUN-PAKT FEATURE

To add packing, you simply insert a plug of Yarway packing, twist a wrench, and the joint is tight, the job done . . . while *joint is under pressure.*

GUN-PAKT EXPANSION JOINT

...when you install
HAGAN Automatic
Combustion Control
and HAGAN
Ring Balance Meters

HAGAN
HALL
BUROMIN
CALGON

When you install Hagan Automatic Combustion Controls and Hagan Ring Balance Flow Meters, you are certain of accurate and dependable results, low maintenance costs, increased efficiency and economy of operation.

A system of Hagan Automatic Combustion Control is available for your plant, regardless of the number or size of boilers, steam pressure and temperature, or the combination of fuels to be controlled.

Whether your plant operation requires indications, records, or totalizations of flow, in any combination, there is a Hagan Ring Balance Meter built for the job. Any fluid flow—steam, water, liquid fuels, gases, compressed air—can be measured at any pressure up to 15,000 psig. Automatic temperature and pressure compensation of flow readings are available. Two flow readings can be added or subtracted in a single meter.

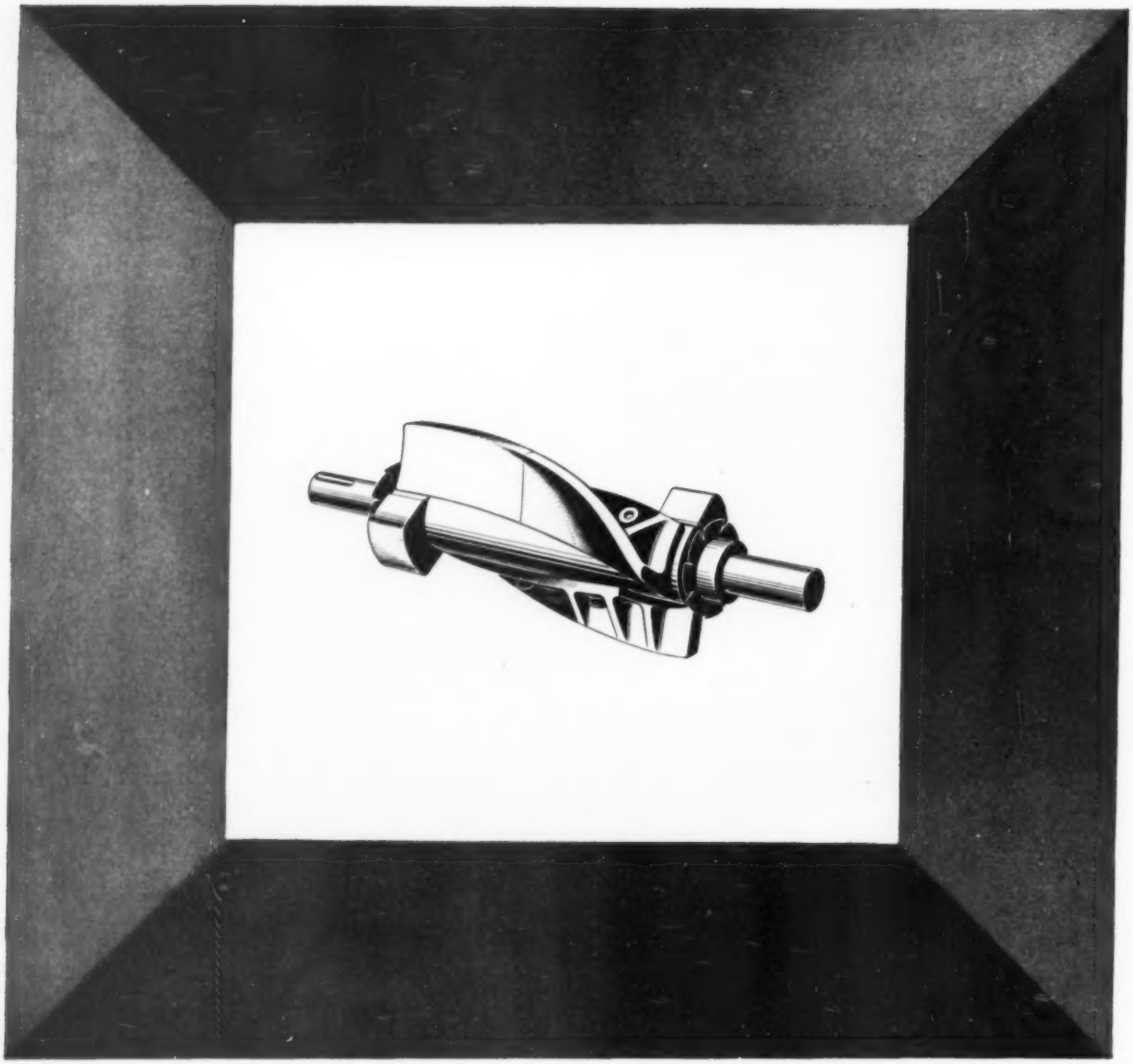
For combustion control and metering systems which are versatile, accurate, and durable, install HAGAN. Our engineers will be glad to show you what HAGAN Combustion Controls and HAGAN Ring Balance Meters can do.

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AUTOMOTIVE AND
AERONAUTICAL TESTING FACILITIES

For more data circle 506 on Post Card



How to make a stoker with Perfect Spread

WHETHER YOU PLAN to buy a new unit or to re-stoker an old one, it must be engineered to assure top efficiency with both low and high ash coals. And a prime requisite for such efficiency is *even* coal distribution over the entire grate . . . the perfect spread that is provided only by American Engineering's unique spiral overthrow rotor.

Supplementing that, you need the exclusive Perfect Spread traveling conveyor feeder that *won't clog . . . not even on wet coal.* This feeder operates on a high traction principle that provides true, *continuous* feeding throughout its whole range of 50 to 7500 lbs. of coal per hour. And for maximum combustion . . . most steam per fuel dollar . . . the special AE cinder return and adjustable overfire air system are unsurpassed.

Perfect Spread Stokers are available in a wide choice of sizes, capacities and grate types. Ask to have an American Engineering Company representative call and discuss your exact requirements.

AMERICAN ENGINEERING COMPANY

2408 ARAMINGO AVE., PHILADELPHIA 25, PA.

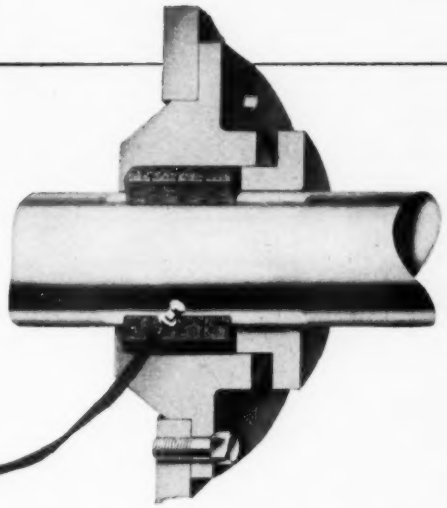
IN CANADA: AFFILIATED ENGINEERING CORPORATIONS, LTD., MONTREAL 2, CANADA

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers.

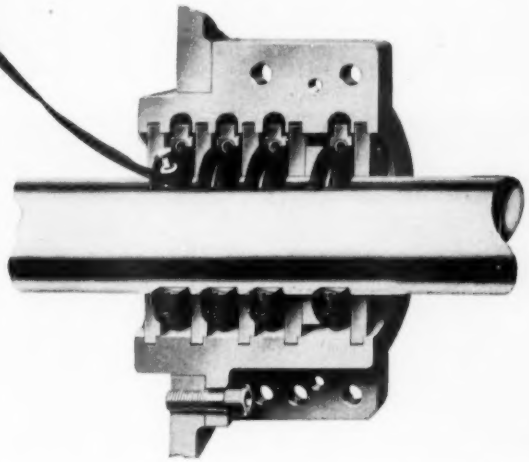
For more data circle 507 on Post Card

COPPUS TURBINES

offer you a choice of packing rings



STANDARD METALLIC RING PACKING — Made of high grade asbestos cores encased in specially treated lubricated aluminum foil. Recommended as a low-friction, long-service packing for steam temperatures up to 850 F and back pressures up to 50 lb. Adjustable packing glands keep leakage at minimum. Easy access to packing rings.



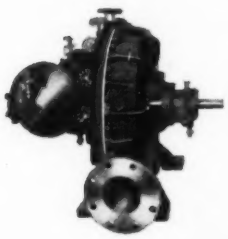
OPTIONAL CARBON RING PACKING — Consists of three carbon packing rings on the pressure side and one beyond the leak-off section. Each ring has three segments held together by a stainless steel garter spring. For back pressures up to 75 lb. Standard for vacuum or gas operation, or when leak-off is desired.

Heavy chrome plating on shaft at stuffing box is common to both types of Coppus packing.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

FIT TURBINE COSTS TO HORSEPOWER NEEDS

When you buy turbines rated close to your exact horsepower needs, you save plenty of money. That's because turbines are generally priced in proportion to their size. The wide range of sizes of Coppus Turbines promises purchasing economy for you from the 150 hp size down to the smallest. As for operating and maintenance economies, you get them, too, from such other features as: greater number of manually operated valves for individual control of steam nozzles; replaceable cartridge-type bearing housings and others. For complete details . . .



WRITE FOR BULLETIN 135
COPPUS ENGINEERING CORPORATION
164 Park Avenue
Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

For more data circle 508 on Post Card

Varying Water Conditions?

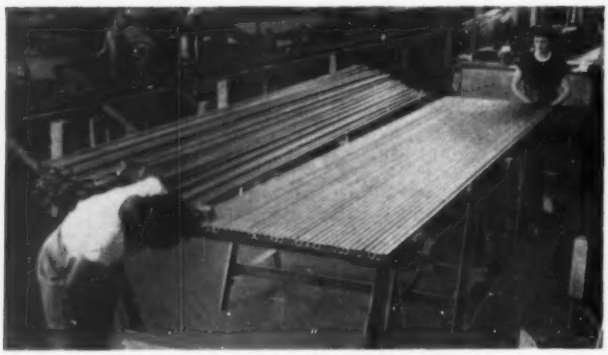
Acid Action?

Varying Temperatures?

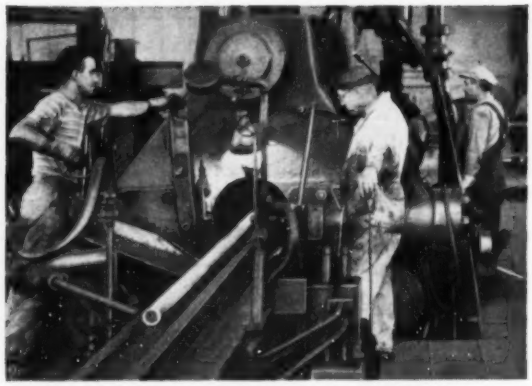
FACING TUBE

Heat Coolers...

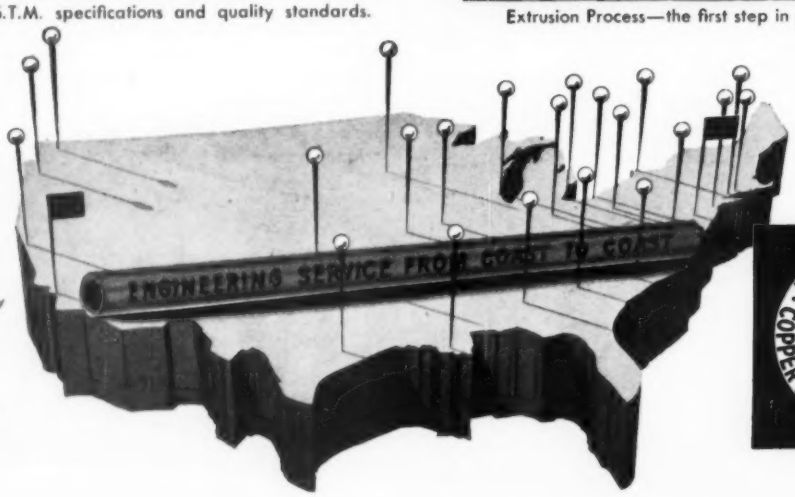
PUT PHELPS DODGE



Tubes are hydrostatically tested and inspected to meet latest A.S.T.M. specifications and quality standards.



Extrusion Process—the first step in producing tubes.

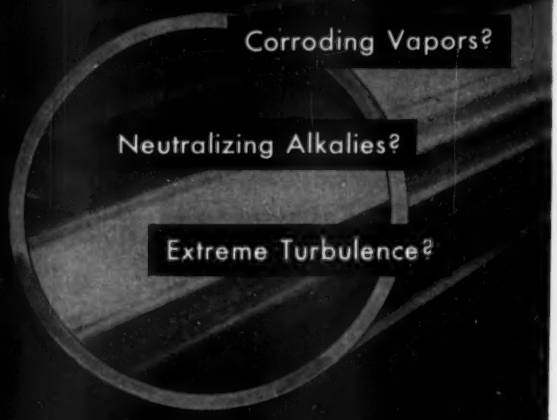


TUBE MILLS IN:
Los Angeles, Calif.
Bayway, New Jersey

DISTRICT OFFICES
at key points

PHELPS DODGE COPPER PRODUCTS CORPORATION
P D
WIRE TO MARKET

PROBLEMS IN *Exchangers... Evaporators?*



"KNOW-HOW" TO WORK !

- *Specialists in tubes for heat exchangers, coolers and evaporators,* with years of experience in solving tough tube-operating problems.
- *Pioneers* in "trouble-shooting" service. Research personnel and facilities second to none.
- *Highest quality*—assured by Phelps Dodge Hot-Forged, Extrusion Process and exacting mill control through every step of tube manufacture.

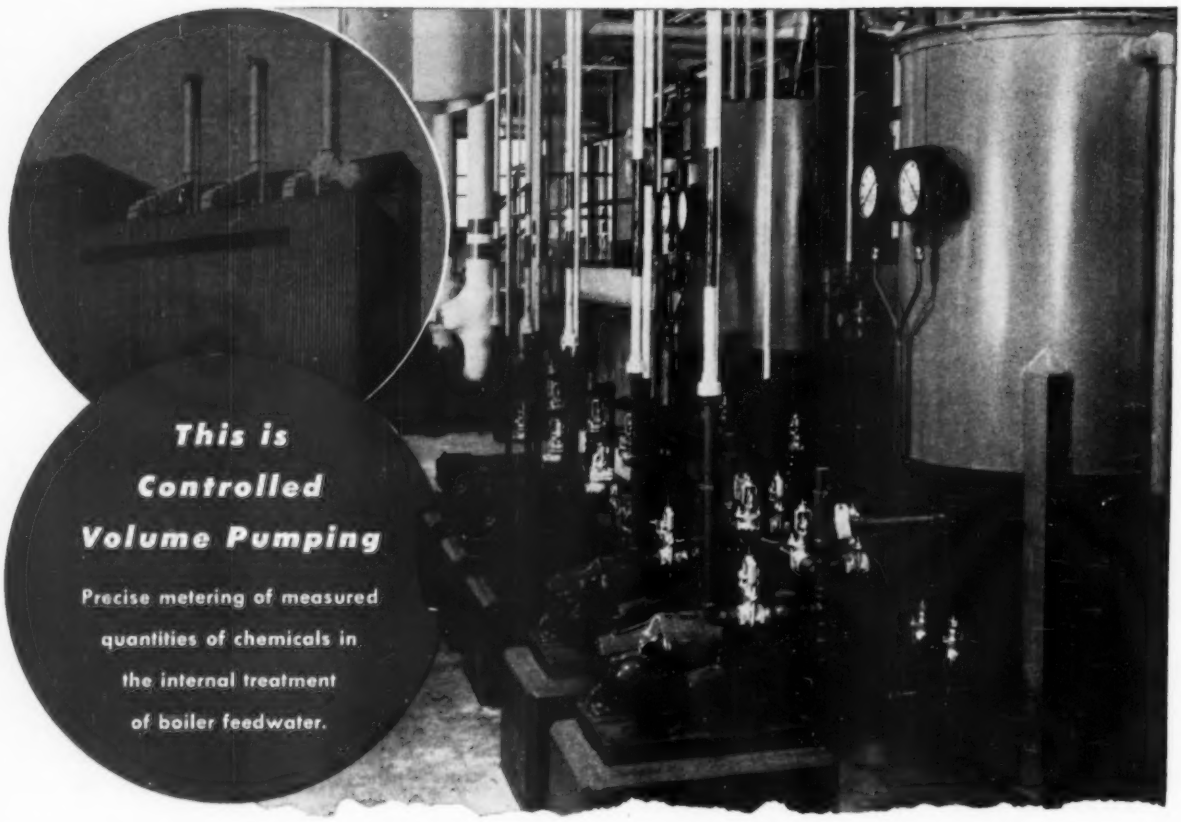
Phelps Dodge Heat Exchanger Tubes are available in following alloy combinations:

Admiralty (plain or inhibited)	Cupro-Nickel, 30%
Admiralty (Blackskin)	Cupro-Nickel, 20%
Aluminum Brass	Cupro-Nickel, 10%
Aluminum Bronze	Superloy
Red Brass	Copper (Deoxidized and Arsenical)

PHELPS DODGE COPPER PRODUCTS CORPORATION

40 WALL STREET, NEW YORK 5, N. Y.

For more data circle 509 on Post Card



THESE MILTON ROY CONTROLLED VOLUME PUMPS DO THE JOB . . .

The modern Beloit, Wisconsin steam generating plant of Fairbanks, Morse & Co., manufacturers of diesel engines, locomotives, generators, pumps, motors and magnetos, is designed to handle heavy processing loads and plant heating. To help maintain the continuity of service so vital to power plant operation, company engineers placed emphasis on methods of preventing corrosion and other destructive conditions in the boiler feedwater system. Five Milton Roy Controlled Volume Simplex Pumps are employed to meter precise quantities of chemicals into the boiler feedwater: disodium phosphate for residual water hardness in the boiler drums; sodium sulphite for oxygen removal in the deaerator and feed lines; organics for prevention of precipitation in economizer and feed line; alkalene polyamide as anti-foam for reduction of surface tension; octadecylamine for steam and return line corrosion. Fairbanks, Morse & Co. specified Milton Roy Controlled Volume Pumps because of their metering accuracy, service dependability, positive and flexible control, low maintenance.

Boiler feedwater treatment is only one of many applications of Milton Roy Controlled Volume Pumps. They're also used in all forms of internal and external feed systems, including introduction of chemicals directly to boiler drums, intermittent feeding followed by condensate flushing, automatic chemical injection in ratio to flow, automatic pH control, and automatic control by conductivity.

These versatile pumps offer positive, precision control and metering of chemicals at any pressure requirements. As air-powered or motor-driven units or as components of automatic systems, Milton Roy pumps ensure utmost accuracy.

For additional information on Milton Roy Controlled Volume Pumps and Automatic Chemical Feed Systems, call the Milton Roy field representatives listed in your classified telephone directory. Or get in touch with us.

Manufacturing Engineers

WITH THE EXCLUSIVE STEP-VALVE DESIGN

MILTON Roy COMPANY

1320 EAST MERMAID LANE, PHILADELPHIA 18, PA.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

For more data circle 510 on Post Card

LADISH

Controlled Quality

PIPE FITTINGS

reduce piping assembly time

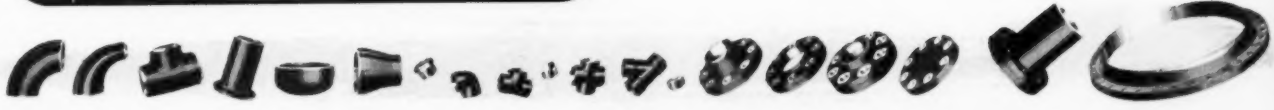
Makeup goes smoother . . . with less chance for delay . . . on those piping systems where Ladish fittings are installed. Ladish Controlled Quality makes the difference. By exacting controls over materials and manufacturing processes . . . Controlled Quality assures uniform weldability through metallurgical integrity, fast assembly through dimensional accuracy and provides a real assurance of ultimate operating economy and complete dependability . . . reasons why it pays to specify LADISH.

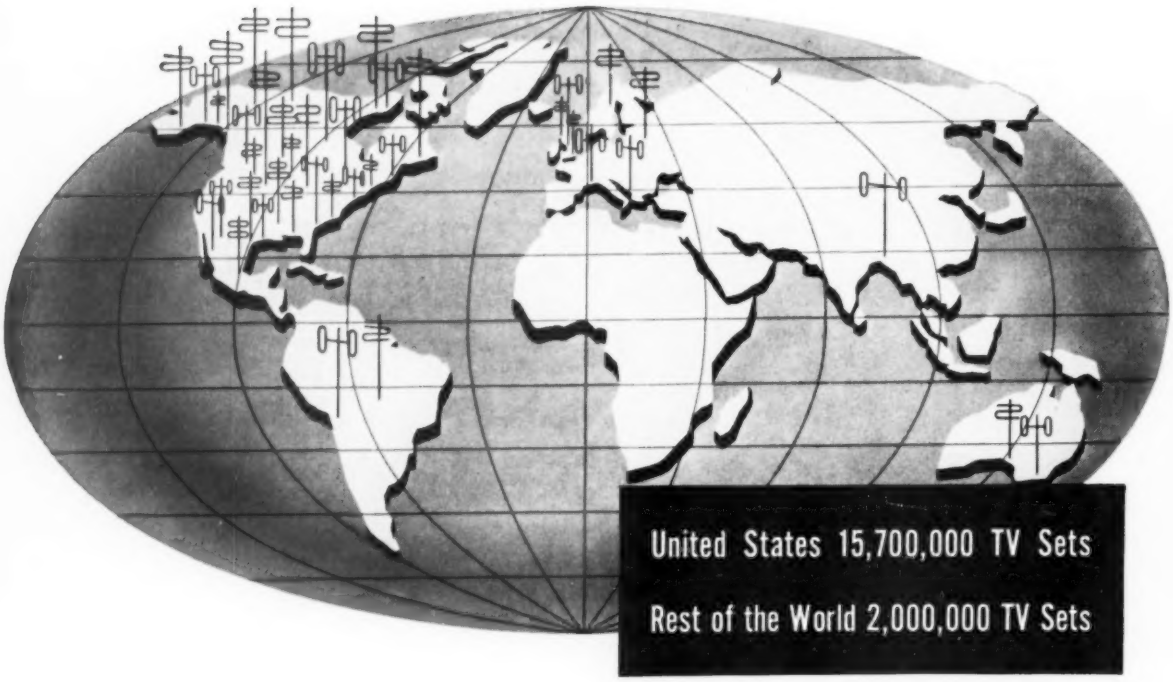
THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul
St. Louis • Atlanta • Houston • Tulsa • Los Angeles • San Francisco • Havana • Mexico City • Brantford, Ont.





COMPETITION Turns Luxuries into Necessities

Two millions of people throughout the world, washing machines, radios and television sets are miraculous inventions remote from their lives . . . for the wealthy only.

In the United States, however, a new product appears in no time in the homes of wage earners as well as salaried executives.

Consider television, for example. Only 6,500 sets produced in 1946 . . . over 5,000,000 in 1951. Or washing machines . . . more than 24,000,000 in 10 years.

What has Competition to do with this?

Do you think we'd continue to get more and better products if only one company made each item or each line?

No! We get more and better products here in America, because anybody who thinks he can make anything better or sell it more efficiently is free to try.

And many succeed. Take electrical products like radios and television sets . . . and home appliances like washing machines and electric fans. Does the biggest company monopolize this industry? Not by a long shot! Even counting all its affiliated companies, it still sells less than 1/5 of such products bought in this country.

There are nearly a thousand other companies that make home appliances, radios and television sets. And they do more than 4/5's of the business! The smallest of them make the biggest companies hustle their bones to keep making products better and better.

In America, a better product can always win consumer acceptance in any field.

Let's keep the COMPETITIVE SYSTEM working for us

The Competitive System can be killed! When industries are run by government, when taxes are so high that they destroy the incentive to work hard and risk savings in business ventures, the Competitive System languishes and dies.

You've seen it happen in other lands. Let's not let it happen here.

Let's all of us watch closely to see that those who represent us in government are working with us and for us to preserve our Competitive System; to assure a tax structure that leaves enough incentive to make hard work worthwhile, so that *any* man with ability and energy has a chance to earn good money and keep most of it.

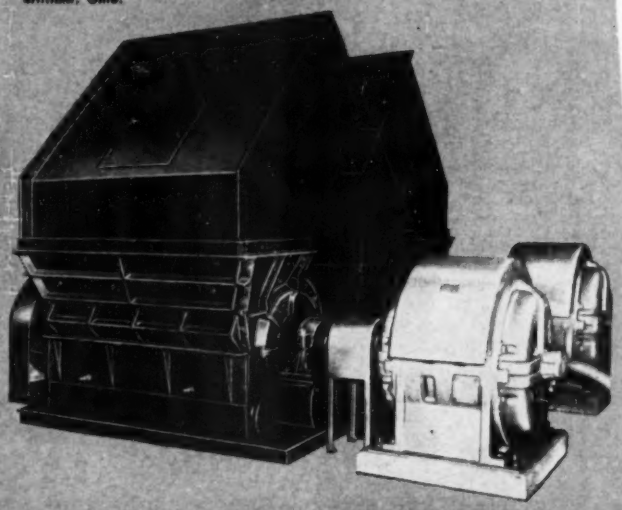
Competition thrives best where the rewards are high. People live best where competition thrives.

This report on PROGRESS-FOR-PEOPLE is published by this magazine in cooperation with National Business Publications, Inc., as a public service. This material, including illustration, may be used, with or without credit, in plant city advertisements, employee publications, house organs, speeches or in any other manner.

THE COMPETITIVE SYSTEM DELIVERS THE MOST TO THE GREATEST NUMBER OF PEOPLE

Check *American* Quality—Feature by Feature—and you'll know

Four Million Tons of Coal Crushed in Six Years! Reducing 16" ROM to a ¼" product, at the rate of 900 tons per hour, is the performance record of this American 60S twin-crusher installation at the Tidd Plant of the Ohio Power Co., Brilliant, Ohio.



WHY AMERICAN CRUSHERS can reduce coal for less than

per ton

AMERICAN Feature No. 2

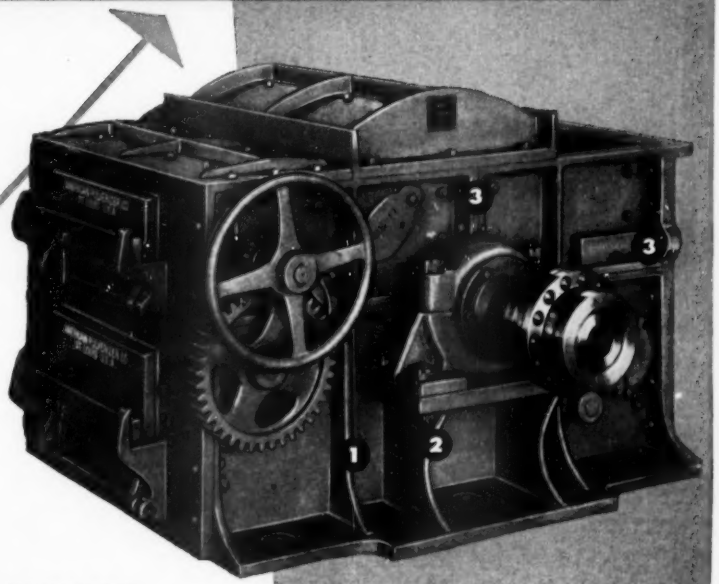
STRONGLY RIBBED STEEL FRAME

The frame of an American Crusher consists of:

1. **Side Frames of Heavy, Ribbed Steel Castings,** accurately machined on special jigs and fixtures. Each abutting joint is machined for dust-tight fit. All other members are of heavy plate steel.
2. **Integral Bearing Pedestals.** Cast in one piece with the side frames to assure maximum rigidity.
3. **Sectional Design.** All members of the crusher frame are securely bolted together by means of coupling bolts rather than machine bolts—to provide a much stronger and more rigid joint. The sectional design permits easy dismantling of the crusher, or quick inspection of parts for check on wear or replacements.

American Crushers are designed for a lifetime of wear. The crushing chamber of every American is completely protected with renewable liners of the proper thickness and material for every job.

WRITE for Coal Crushing Bulletin



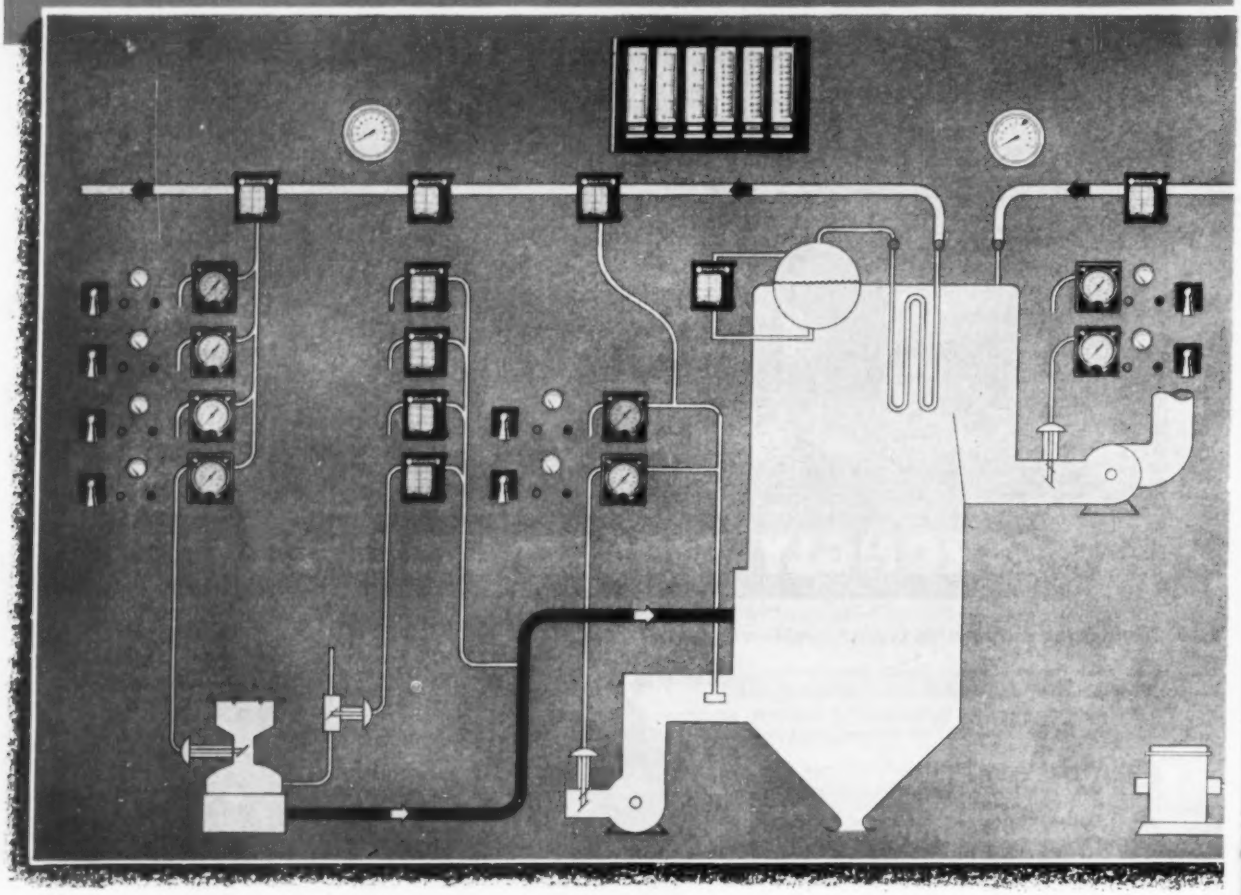
American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1431 Macklind Ave.
St. Louis 10, Mo.

For more data circle 512 on Post Card

. . . a NEW approach to



Graphic panel with miniature instruments. Console or conventional panels also available. Combustion control from steam flow-air flow, or fuel-air ratio . . . feed water from three, two or one influences. Steam temperature control is multi-element. Soot blowing is automatic-sequential. *Write for Bulletin 1007 on complete Copes-Vulcan Boiler Control.*

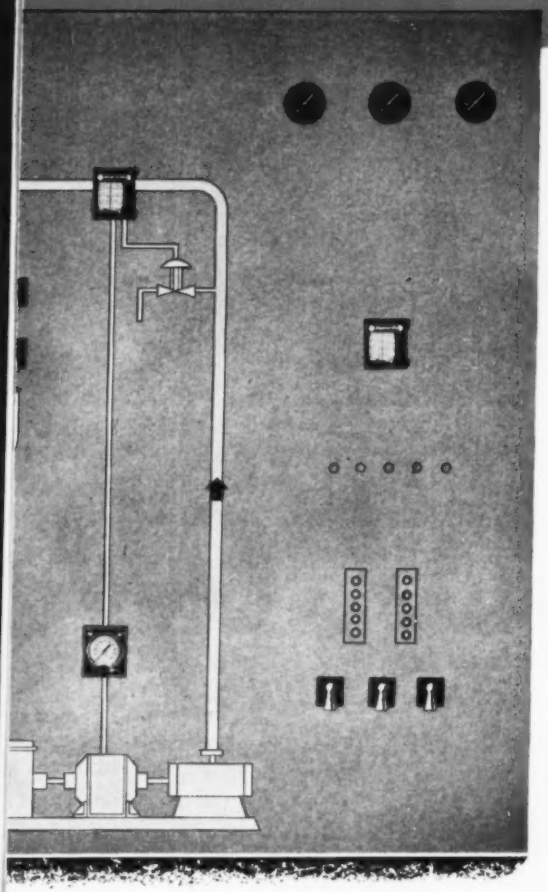
WHAT'S IN A NAME?

COPES has for half a century specialized in the control of boiler feed water flow and pressure, boiler water level—and, more recently, boiler steam temperature.

VULCAN has since 1903 brought soot blowing from an act of drudgery to the ease and convenience of merely pushing a button at a centrally located control panel.

Taylor has for over 100 years led in instruments for measuring and controlling temperature, pressure, flow and liquid level in the process and power fields.

BOILER CONTROL



C·V+T=BBC

COPES · VULCAN + *Taylor* = BETTER BOILER CONTROL

This new formula is based on three old and respected names in power and process controls. Each contributes skills and experience that make the equation add up to Better Boiler Control.

Give us the opportunity to demonstrate how this formula can work to your advantage. The new Copes-Vulcan approach to your boiler control problem will pay off in smoother, safer and more efficient boiler operation.

And Copes-Vulcan assumes undivided responsibility—starting with system design and continuing through the life of the installation with on-the-job service, *whenever* or *wherever* needed.

COPES-VULCAN DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
ERIE, PENNSYLVANIA

COPES VULCAN

BOILER CONTROL

WITH INSTRUMENTATION
BY *Taylor*

For more data circle 513 on Post Card

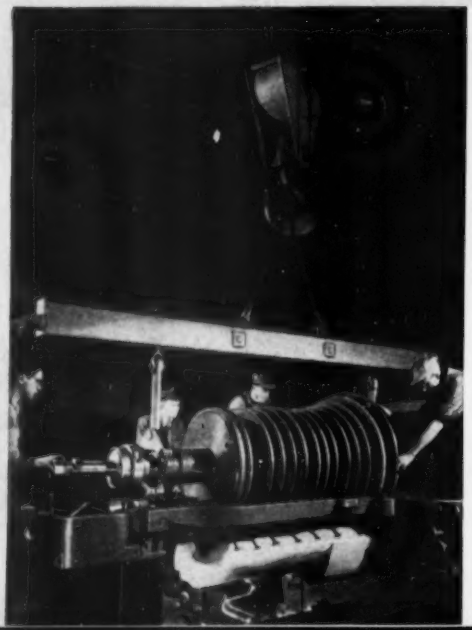
From Shop

HERE'S HOW Allis-Chalmers Builds the Generator Unit that's Easy to Install, Low in Foundation Cost

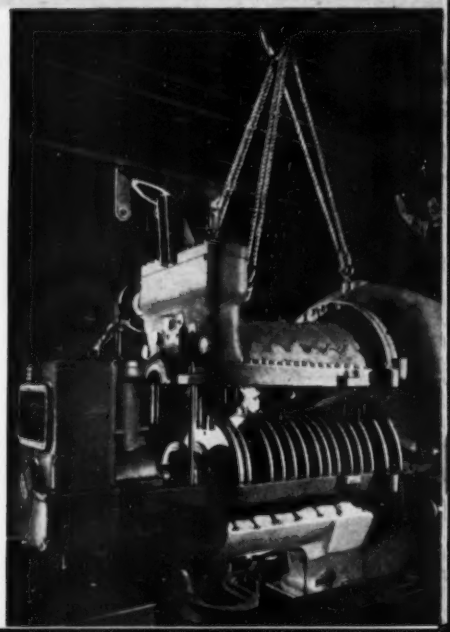
MODERN Allis-Chalmers WA-Series steam turbine generating units are factory tested and shipped with rotors locked in place to save you installation time. Oil piping and generator air coolers are both above the floor line to reduce your foundation costs.

WA-Series units are built in ratings from 2000 to 7500 kw for either condensing or non-condensing operation. For your copy of Bulletin 03B7654, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3910

1 Precision balanced turbine rotor assembly being lowered into casing. All wheels have durable chrome alloy steel buckets.



2 Upper half casing of this compact impulse steam turbine is next added in the process of assembling the WA-Series unit.

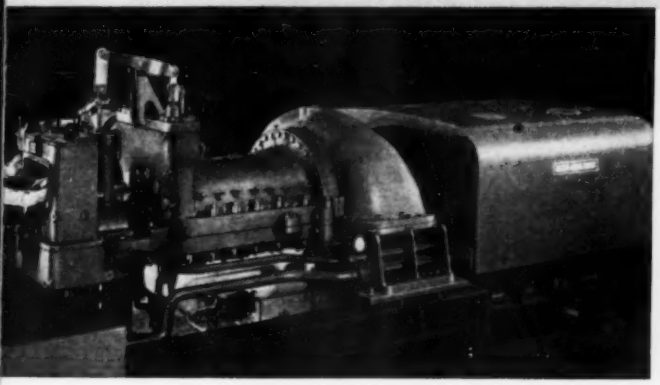


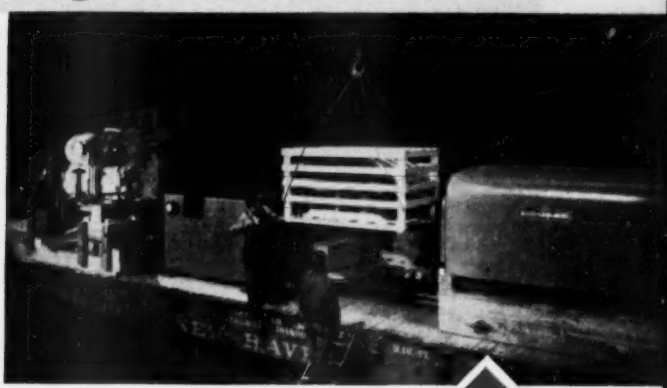
Installed and running... the WA-Series unit: 3000 kw, 3600 rpm, 400 psig, 750 F, 2 in. Hg abs.

to Shipment!

3 Assembled 3-bearing unit — complete with housing type air cooled generator — ready for factory testing. **Both oil piping and generator air coolers are above the floor line.**

4 Entire WA-Series 3000-kw unit—pre-tested and insulated—being loaded on **one** flatcar for unit shipment. Both turbine and generator are shipped with their **rotors securely locked in place.**





ALLIS-CHALMERS

World's Widest Range of Power Plant Equipment

A-C ALLIS-CHALMERS

For more data circle 514 on Post Card

Harnessing heat for all industry

HEAT is one of man's most useful servants. With it, he can separate gasoline from crude oil . . . cook food . . . generate electricity . . . refine steel from raw ore and roll it into mile-long sheets. But to do these and countless other jobs, heat must be applied in the correct amounts . . . to obtain critical temperature values.

Forward-looking research and production men realized some years ago that "rule of thumb" was entirely inadequate for replacing complex processes. They needed facts obtainable only from automatic measurement . . . performance possible only through automatic control.

Honeywell has consistently led the way toward new and better temperature instrumentation. Continuing research has developed sensing elements which cover the full temperature spectrum . . . instruments which provide the desired accuracy . . . and automatic controls which can regulate any production process.

instruments

The complete Honeywell family offers a broad choice of characteristics to suit individual applications. *ElectroniK* indicators, circular chart and strip chart recorders and controllers afford the peak in performance through "Continuous Balance" high-speed electronic measurement. *Pyr-O-Vane* millivoltmeter instruments fit many processes which need accurate indication and control. Brown Thermometers are economical instruments for recording and controlling moderate temperatures.

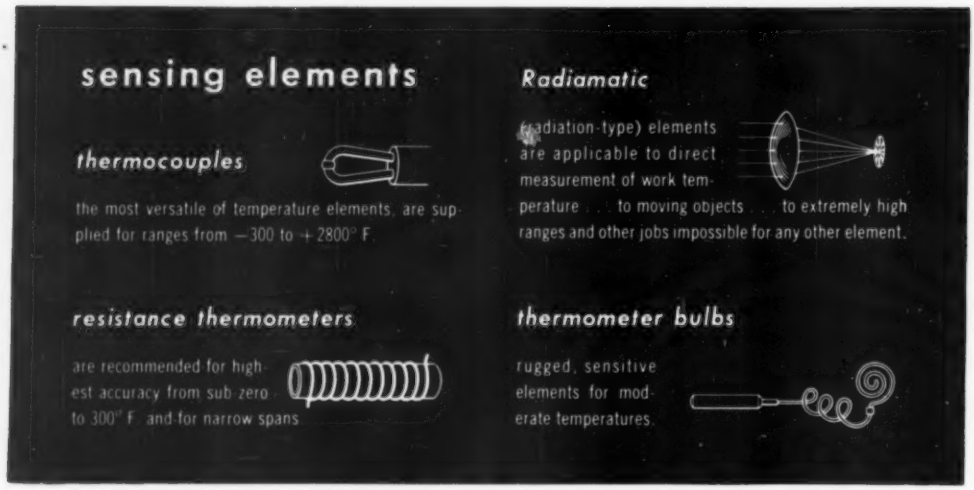
controls

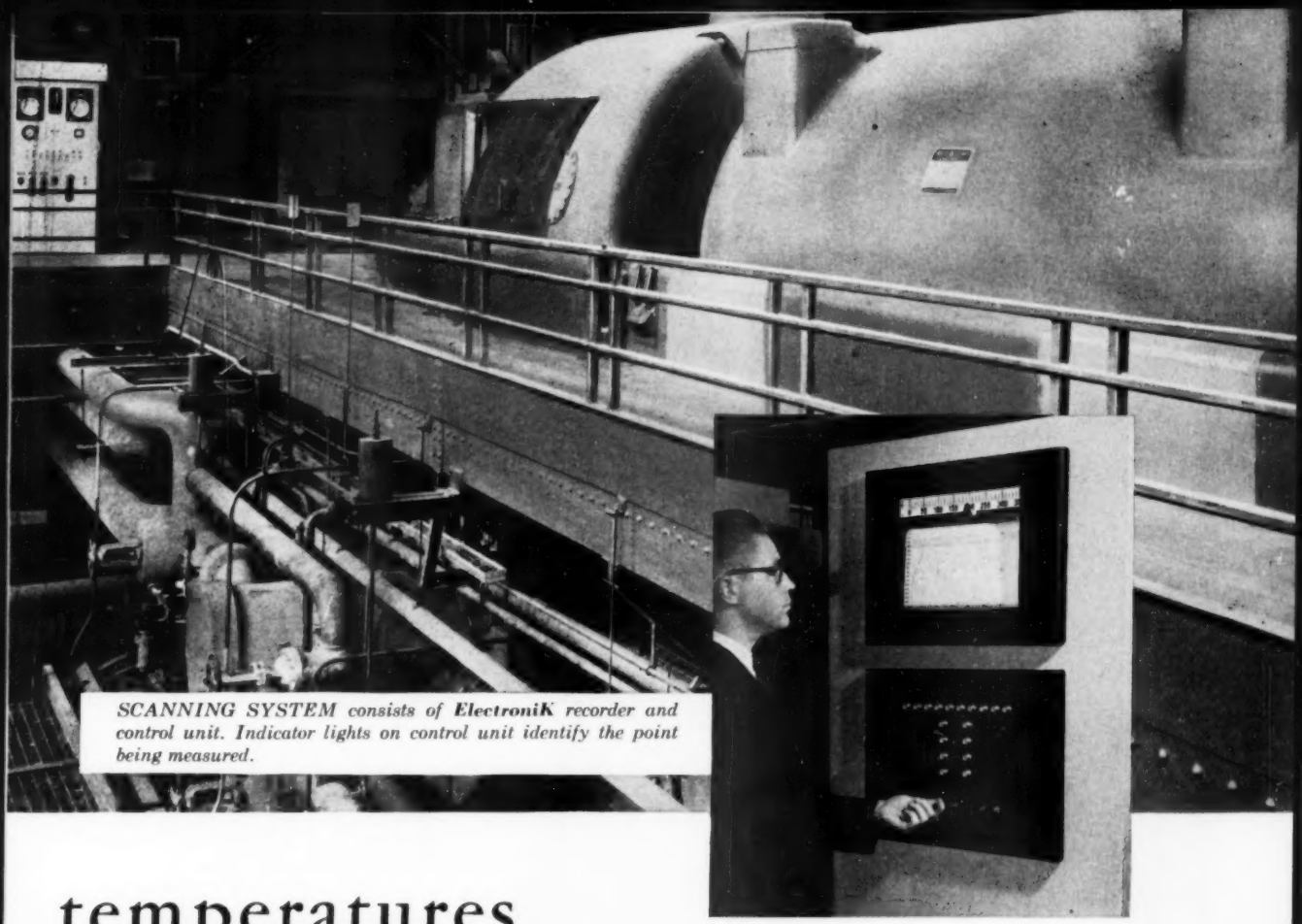
With *Pyr-O-Vane* instruments you can have electric control of either the two-position, three-position or time-proportioning types.

With Thermometers, you may choose from electric two-position, pneumatic on-off or proportioning control, and cam-operated program control.

With *ElectroniK* instruments, your selection covers practically any form of electric or pneumatic control, including the most advanced types suitable for complex processes, and the most flexible program controls.

Watch 270 plant *with the*


sensing elements
thermocouples
the most versatile of temperature elements, are supplied for ranges from −300 to +2800° F.
Radiamatic
(radiation-type) elements are applicable to direct measurement of work temperature . . . to moving objects . . . to extremely high ranges and other jobs impossible for any other element.
resistance thermometers
are recommended for highest accuracy from sub-zero to 300° F. and for narrow spans.
thermometer bulbs
rugged, sensitive elements for moderate temperatures.



SCANNING SYSTEM consists of ***ElectroniK*** *recorder and control unit. Indicator lights on control unit identify the point being measured.*

temperatures *ElectroniK* scanner

IT'S EASY and economical to keep constant watch over temperatures of potential trouble spots throughout the plant, when you have an *ElectroniK* Scanning System. From a central point, you can monitor temperatures of bearings, hydraulic couplings, boiler tubes, cooling oil lines . . . at surprisingly low cost per point.

This instrument can concentrate data from as many as 270 different locations. It scans through successive thermocouple points at a rate as fast as one second per point . . . re-checking each point at approximately four-minute intervals.

At the operator's choice, it can perform these various functions: simple scanning without recording, continuous recording of all 270 points, selective recording, recording of points which depart from specified limits, and operation of annunciator contacts when any temperature exceeds a pre-set point. The chart moves only when the instrument is actually recording. Separate temperature limits can be set for each bank of 9 thermocouples.

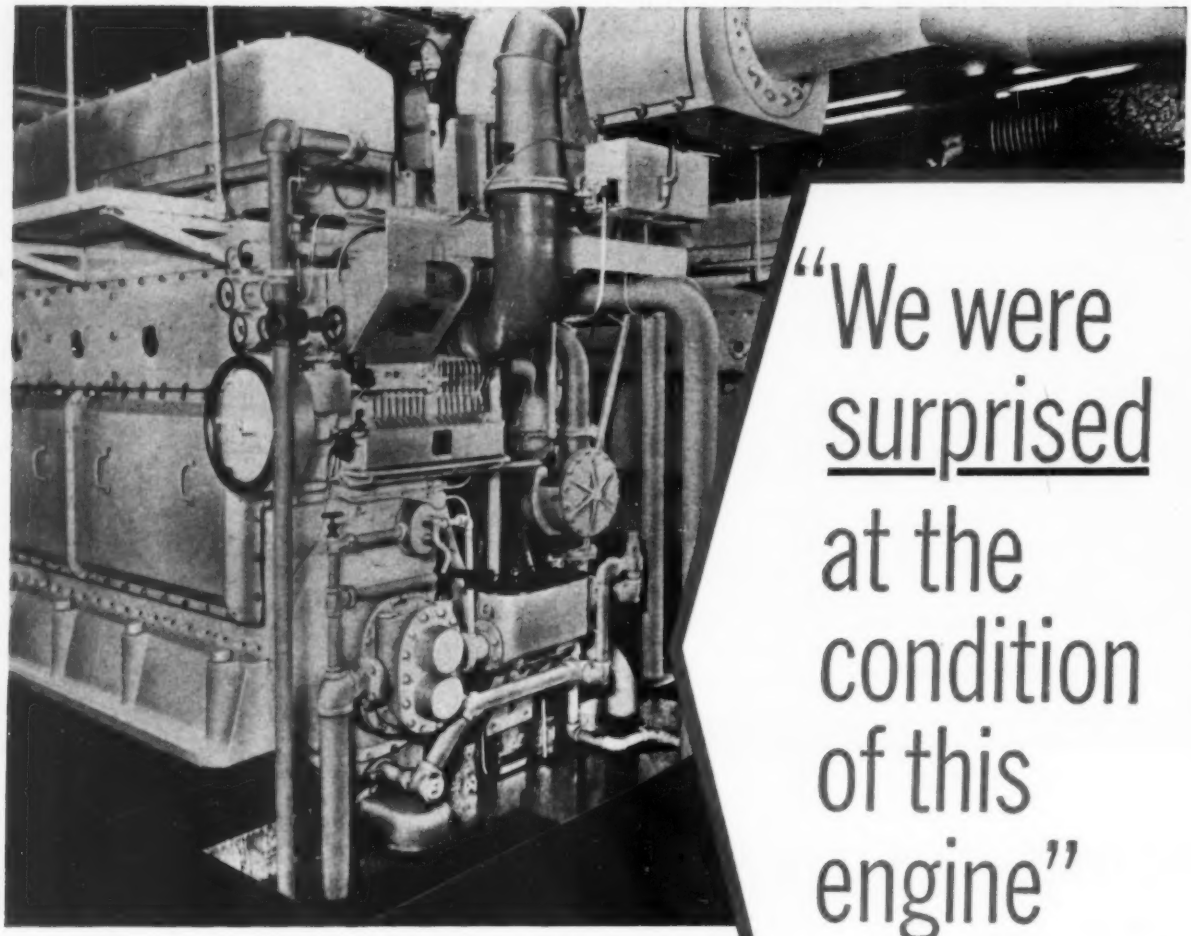
Your local Honeywell engineering representative will be glad to discuss how this instrument can help you protect plant equipment economically. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4587 Wayne Ave., Philadelphia 44, Penna.

● **REFERENCE DATA:** Write for Data Sheet No. 10.0-9, "*ElectroniK* Scanning System," and Catalog 90-2, "Supervisory Instruments for Power Generation."

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

For more data circle 515 on Post Card



"We were surprised at the condition of this engine"

... says G. V. Yarger,
Supt. Municipal Utilities
Waverly, Iowa

"When we finally opened up our Worthington, it was in the *best* condition I've ever seen a diesel engine that had operated such long hours and under such heavy loads as this unit. It had a total of 48,926 hours on it – 8,987 hours of tough operation since the last overhaul.

Mr. Yarger continues, "We've been using Sinclair RUBILENE® Heavy in the crankcase and RUBILENE H.D. 30 in the cylinder lubricator. These RUBILENES have kept the crankcase and upper portions of the cylinders exceptionally clean and bright, with no sign of carbon or deposits."

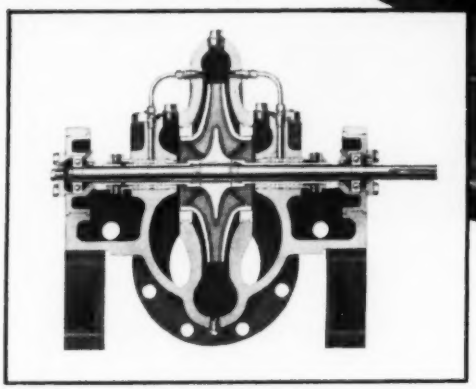
That's a typical report on the exceptional qualities of the Sinclair RUBILENES ... evidence that they could improve the efficiency of *your* diesels, too. Why not switch now? Contact your nearest Sinclair Representative or write Sinclair Refining Company, 600 Fifth Avenue, New York 20, N. Y.

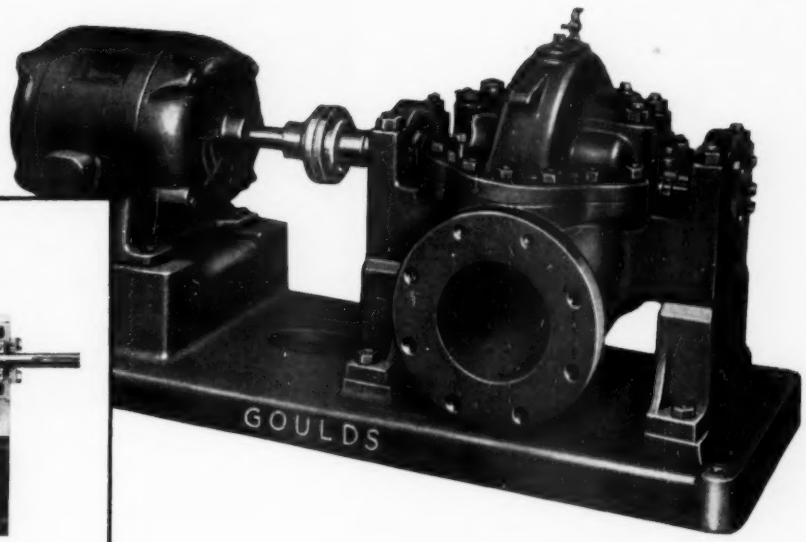
SINCLAIR DIESEL OILS

save wear and replacements

For more data circle 516 on Post Card

The new Goulds Fig. 3405 double-suction, single-stage, horizontally split casing centrifugal pump for general purpose pumping. 19 sizes. Capacities from 200 GPM to 6400 GPM. Heads up to 260 ft.





This new pump gives you 5 big cost advantages

The price you pay is only one element of the cost of a pump installation.

Good engineering practice also figures in the cost of pump breakdowns, low operating efficiency, change-overs to meet new conditions, replacement parts inventories, even the floor space the installation takes up.

Here's why the new Goulds centrifugal pump is designed to improve your cost experience in every one of those elements.

1. ***It combines seven design features that mean maximum operating efficiency and minimum maintenance.***

Every one of these construction features is standard with this new design. Together they offer you, without extra cost, a quality of service that's unique in its approach to general liquid handling.

a. Renewable stuffing box bushings.
b. Bearing housings sealed against moisture and dirt.
c. Cowl-type glands suitable for use with quenching liquids.
d. Stainless steel impeller keys.
e. Teflon water seal rings.
f. Die-formed stuffing box packing.
g. Corrosion resistant gland bolts.

2. ***Interchangeability of parts.***

With only three shaft and rotating parts assemblies to provide for 19 pump sizes and 38 pump combinations, this new design offers you a remarkable range of interchangeable parts. A glance at the interchangeability chart on page 7 of the descriptive bulletin will show you:

a. how this design gives you great flexibility in making field changes should your pumping requirements change;
b. why the first cost of this unit is so low due to standardization in manufacture; and
c. how this interchangeability helps to reduce spare parts inventories.

3. ***Compact construction.***

You will be particularly pleased with the short over-all length of this new design. Short bearing spans cut lengths as much as 50%. This means a real saving in floor space.

4. ***Flexibility of stuffing box.***

You can use either conventional stuffing boxes or mechanical seals depending on requirements. And you can change from one to the other in the field if need be.

5. ***Easy rotation change.***

A unique device, locking shaft sleeves, permits you to change from right-hand rotation to left-hand rotation or vice versa in the field without construction changes.

More than 50 years of experience in meeting industry's needs for general purpose centrifugal pumps come to a climax in this design.

GET FULL DETAILS **This 12-page illustrated bulletin, No. 721.6, covers the complete details of the new Goulds Fig. 3405, including specifications, interchangeability tables and performance curves. Be sure you have the whole cost-advantage story before you select another general purpose pump. Contact your nearest Goulds representative or mail the coupon below today.**

GOULDS PUMPS, INC., Dept. PE, Seneca Falls, N.Y.

Please send me Bulletin No. 721.6 describing the new Fig. 3405 centrifugal pump.

Name_____

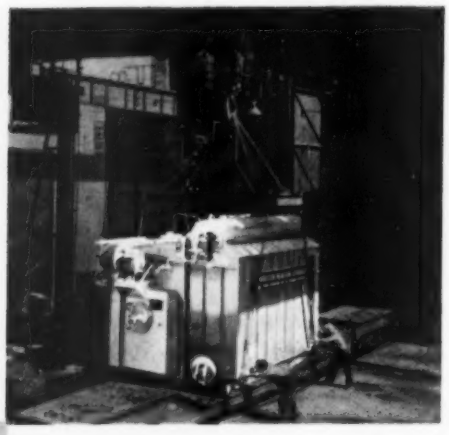
Company_____

Address_____

City_____ State_____

Goulds PUMPS INC. Seneca Falls New York

For more data circle 517 on Post Card



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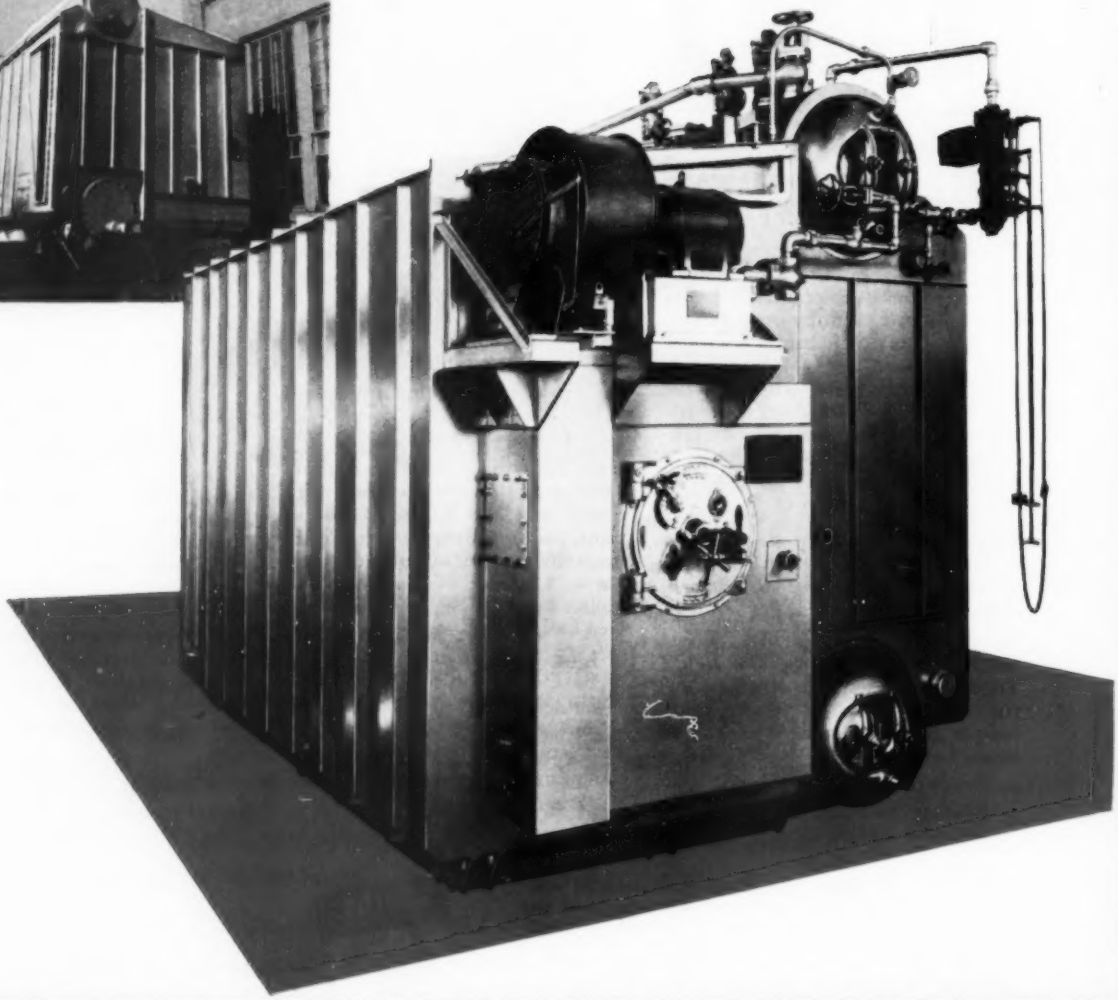

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

VP Boiler...

THE PACKAGE BOILER WITH *extra* FEATURES

Most of the water-tube "package" boilers available today look very much alike. As a matter of fact, in some respects they are alike.

The prospective purchaser's job is to discover which of the several package boilers now available offers a combination of features and advantages that adds up to the "best buy".

Consider, then, the fact that the C-E Package Boiler, Type VP, has *all* the design features offered by any of its contemporaries *plus* the following extras—

Fully Water-Cooled Furnace – Even the front or "burner" wall is protected, except in three smallest sizes. Has higher ratio of furnace-wall cooling to furnace volume than any boiler of its size and type. Assures rapid and efficient heat absorption, lower gas temperatures entering convection bank, reduced tendency to slag formation. Minimizes furnace maintenance.

Larger Lower Drum – The large lower drum, 30″ in diameter, permits simple, symmetrical tube arrangement; provides easy access when necessary for washing down or for inspection; greater water storage capacity facilitates handling fluctuating loads.

Centrifugal Fan – This type of fan is more efficient, operates at lower speed and is quiet in operation. The average noise level is less than half that of typical high-speed blowers used on most boilers of this type. Low noise level is particularly advantageous in confined space and in such installations as hospitals.

Simple Baffle Arrangement – Minimum changes in direction (no baffle at all in convection bank in larger size units). Gives lower draft loss. Simplifies soot blowing. Cross-flow of gas with elimination of dead pockets gives maximum heat pick-up. Water-cooled baffle in intermediate sizes ensures minimum maintenance.

VP Boilers are available in capacities from 4,000 to 30,000 lb of steam per hr; pressures to 250 psi. Send for Bulletin VP-11.

B-652

— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

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ALLIS-CHALMERS
PUMP
Laboratory

Check

Suction Bay and Pump Performance in Advance

Use this Allis-Chalmers pump laboratory to duplicate your suction bay design and operating conditions.

WHY CHANCE EXPENSIVE BUILDING ALTERATIONS when you can be sure of suction bay and circulating pump performance in advance. In the Allis-Chalmers pump laboratory, an exact scale model of your suction bay can be built. Then you observe the effects of different foundation arrangements . . . can check efficiencies under partial load . . . test the ultimate capacity of your design in case of expansion . . . see what happens under different water conditions. This way you can be sure that you have the right design, down to the last detail.

Available to Power Plant Operators and Consulting Engineers

The Allis-Chalmers pump laboratory is located at the West Allis, Wisconsin, Works and is available for use for all power plant operators and consulting engineers with large pump and water supply problems. For details of the services available, call your Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3973

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

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You're Always on the Safe Side

WHEN YOU SPECIFY

ASHCROFT Maxisafe DURAGAUGES

Here is the gauge that provides absolute protection to the viewer from tube rupture due to any cause.

In this new Ashcroft Maxisafe* Duragauge, an integrally cast solid wall separates the dial from the Bourdon tube and movement. The entire back of the case is covered by a double spring-mounted safety release plate. Teflon coated and tightly fitted on a rubber gasket, the plate is held in place by a knurled knob. If the tube ruptures, pressure less than ½ p.s.i. will force the plate open and vent the discharge to the rear.

Always be on the safe side. Get absolute protection against the possibility of tube rupture — specify the Ashcroft *Maxisafe* Duragauge. The *Maxisafe* has all the long-life durability and precision accuracy of standard Ashcroft Duragauges. It's available in all Duragauge pressure ranges, Bourdon tube materials, case designs (except Types 1179 and 1279), and mountings, in 4½, 6 and 8½ inch dial sizes. Ask for details in selecting *Maxisafe* Duragauges. Phone your local Ashcroft Gauge Distributor.

*Reg.

NOTE THE SOLID WALL

that separates the dial from the Bourdon Tube and movement. Three ¾" lugs on the back flange hold the *Maxisafe* away from the wall and permit the safety plate to release. *The case design also provides easy, quick access to the movement and tube assembly for inspection, repair or recalibration.*

FOR FAST DELIVERY — buy from your Industrial Distributor. He stocks Manning, Maxwell & Moore products locally — saves you the trouble and expense of maintaining a large inventory in your own plant.

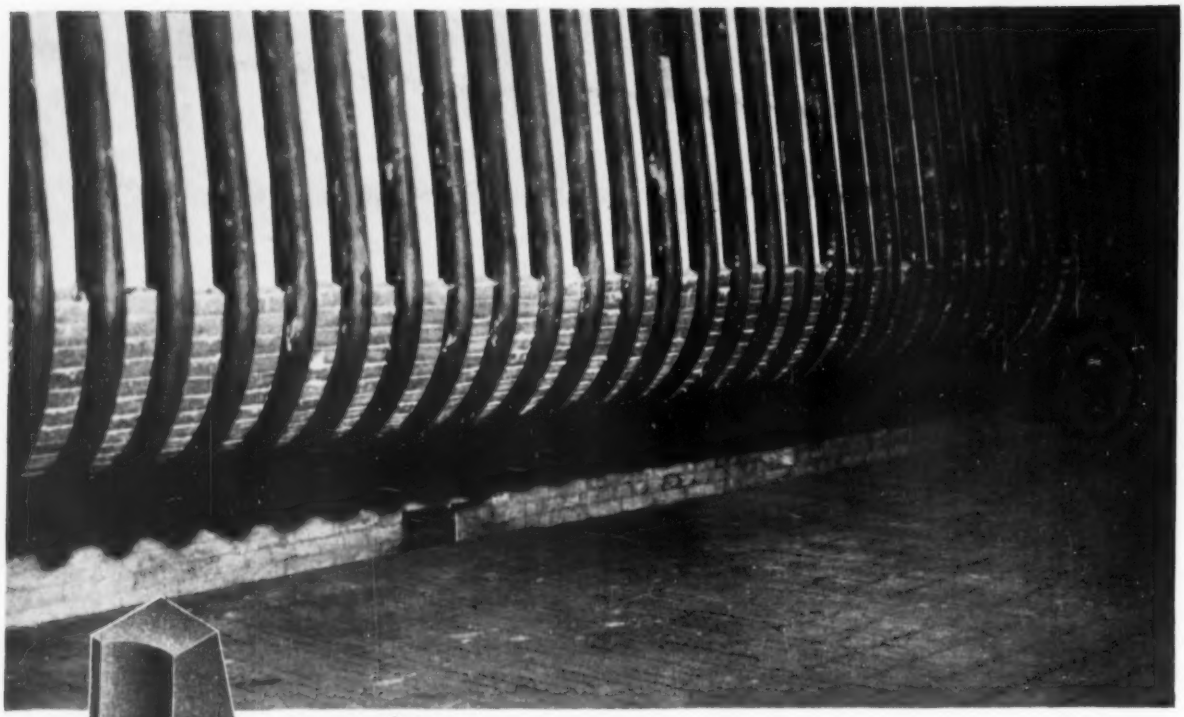
ASHCROFT GAUGES

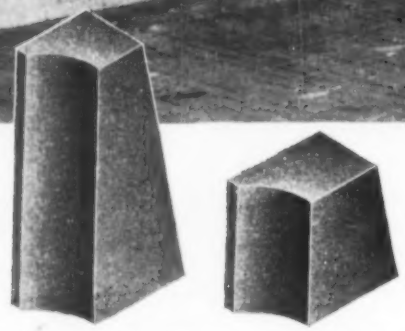
A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more data circle 520 on Post Card

Here's the most effective PROTECTION PLUS HEAT CONDUCTION for your water tube boilers





CRYSTOLON* Armor Blocks

installed between the lower portions of the tubes on a spreader-stoker water tube boiler built by the Riley Stoker Corporation of Worcester, Mass., for the Columbia Cellulose Company, Watson Island, B. C.

Thorough-going protection is just one of many important benefits built into this up-to-the-minute boiler by the use of Norton CRYSTOLON armor blocks.

CRYSTOLON blocks readily conduct heat to the unexposed portions of the tubes, which would be impossible with other types of refractories. Due to this high thermal conductivity, and rapid release of heat, the entire armored area serves as an ignition arch to assure complete combustion of the fuel in the ash pit.

Being extremely dense and refractory, CRYSTOLON blocks are unaffected by the ash encountered in this boiler. Thus they form a valuable protective barrier between the insulating brick behind the tubes and the moving ash bed.

Your own boilers will benefit when you protect them with Norton CRYSTOLON armor blocks, wherever flame impingement or fuel erosion is encountered. Besides their longer, more useful service life they are easy to install or remove. Thanks to their interlocking design they can be laid dry or cemented in place, as desired. You can order them for straight or bent tube sections and for any tube diameter and spacing.

Norton Bulletin 862 contains much valuable information on the properties and selection of refractory brick and cement. Ask your Norton Representative for it, or write direct to NORTON COMPANY, 613 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON

Special REFRACTORIES

Making better products to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

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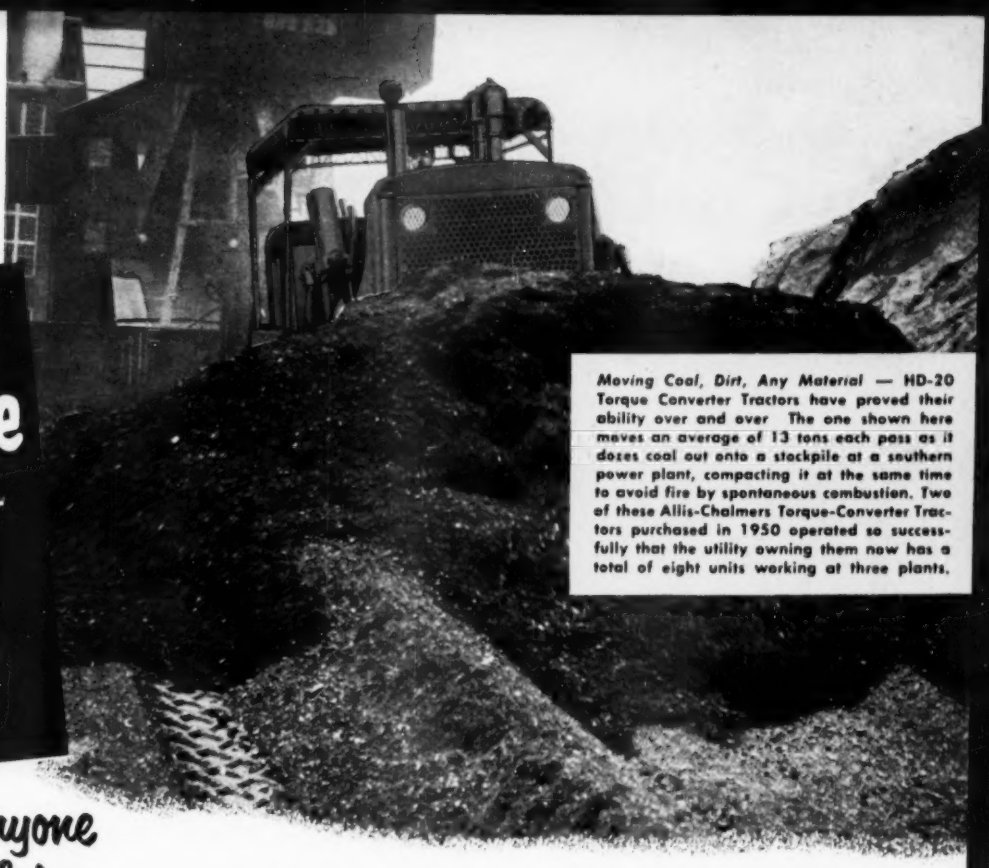
WE say the Allis-Chalmers HD-20 is

Designed to Outproduce

Built to Outlast



Moving Coal, Dirt, Any Material — HD-20 Torque Converter Tractors have proved their ability over and over. The one shown here moves an average of 13 tons each pass as it dozes coal out onto a stockpile at a southern power plant, compacting it at the same time to avoid fire by spontaneous combustion. Two of these Allis-Chalmers Torque-Converter Tractors purchased in 1950 operated so successfully that the utility owning them now has a total of eight units working at three plants.

but anyone can make claims . . . . .

That's why we invite you to get the facts firsthand from HD-20 owners. Just call your nearby Allis-Chalmers dealer. He'll be glad to tell you where you can see these great tractors at work . . . where you can talk to those who own and operate them. When you do, experience tells us you'll hear about these big benefits:

Hydraulic torque converter drive gives the operator the equivalent of hundreds of gear ratios in two speed ranges — automatically selects the proper speed for maximum production. With hydraulic torque converter drive, you take full advantage of available horsepower . . . even at creeping speed. And cushioned protection means fewer repairs . . . longer life of tractor and auxiliary equipment.

In any pushing or pulling work, there's nothing like the HD-20 for sheer productive power. Torque converter actually multiplies torque up to four and one-half times . . . develops tremendous drawbar pull to start the load smoothly, and automatically accelerates to highest speed conditions permit, in either high or low range.

New design. The HD-20 is built to take it — with such design advantages as all-steel welded construction . . . balanced weight and power . . . extra heavy main frame. Hydraulic control permits steering this 20-ton giant with only the touch of a finger.

Easy to service, easy to maintain. 1,000-hour lubrication intervals for truck wheels, idlers, support rollers, no lubrication fittings under tractor. Major units are easily removed without disturbing adjacent parts; adjustments are simple.

See for yourself the many profit-making applications of the HD-20. Ask your Allis-Chalmers dealer to show you this outstanding tractor at work.

41,000 POUNDS

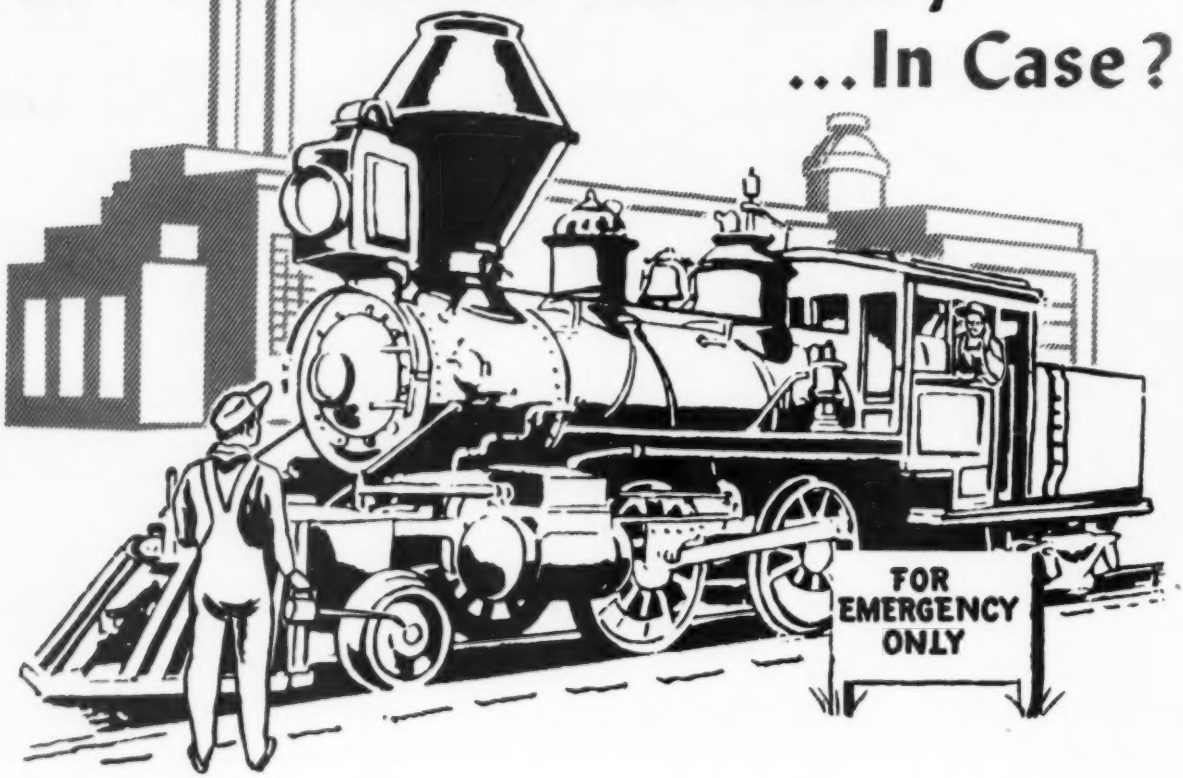
175 NET ENGINE HORSEPOWER

GM 2-CYCLE DIESEL ENGINE

ALLIS-CHALMERS

TRACTOR DIVISION • MILWAUKEE 1, WIS.

Got a Locomotive Handy ...In Case?



EVERY so often a steam locomotive makes news by going to the rescue of a plant where the steam system gave out at a critical time.

This is one answer to continued steam production pending repairs . . . and undoubtedly an expensive one. Simplest—and most economical—is to use the Nalco System and eliminate the chances of boiler down time due to faulty water treatment.

Nalco chemicals and services aim at *water treatment results* from raw water intake to condensate hot well . . . And the thousands of plants now using the Nalco System testify to the accuracy of this aim during the past twenty-six years. Whether your plant is large or small; your water problems scale, corrosion, carry-over—or just plain high cost—unless you have a locomotive handy for emergencies, better check with Nalco today. No obligation . . . and an excellent chance for permanent water treatment security.

P. S. More steam locomotives use Nalco-treated water than any other kind . . . Perhaps the reason why locomotives *can* be of help in plant emergencies!

NATIONAL ALUMINATE CORPORATION

6222 West 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to
Alchem Limited, Burlington, Ontario, Canada

THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science

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Helpful Bulletins

THE ANSWERS to many of your operating and maintenance problems are found in these new and recently revised catalogs and bulletins. Circle item numbers of all catalogs wanted on the postage-free card below, detach and mail

INSTRUMENTS AND CONTROLS

101 Automatic Controllers — Catalog 1530 contains 56 pp giving factual information on all types of company's ElectroniK control instruments used to measure and control a multiplicity of process variables. Includes detailed specification and control action descriptions and ratings for both electric and pneumatic type controllers. Also presents engineering data on electric control relays. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

102 Control Centers — Multi-unit control centers are featured in 28-pp Bulletin 798 which provides a complete explanation of their purpose and construction and includes unit dimensions and ratings and typical applications. In a section titled, "Pattern for Planning a Control Center," layout charts and floor arrangements are illustrated to simplify planning. Allen-Bradley Co.

103 Temperature Control Manual — A guide to industrial temperature measurement and control, the newly-revised 24-pp Bulletin 101 presents the basic principles of industrial temperature control in practical fashion. Defines types of systems and distinguishes between them. Discusses ways of responding to temperature and putting that response to work, also basic instrument types. Evaluates systems and important considerations in application engineering. Explains influence of firing system on design of control system, principles of mercury-bulb installation, and electrical and mechanical control theory. The Partlow Corp.

104 Flow Meter Specifications — Now offered to power engineers is a set of specification sheets on flow meters. Sheets 241 and 242 cover electric evenly graduated flow meter bodies and mechanical evenly graduated flow meters. Sheets 243 through 247 describe square root flow meters and liquid level meters. Sheet 244 also includes evenly graduated electric flow meters (inductance bridge receivers). Construction and engineering details provided. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

VALVES AND TRAPS

105 Engine Stop Valve — Bulletin S-3, 6 pp, describes company's "cushioned" automatic engine stop valve. Covers its application, installation and design and includes a complete parts list, dimensions and complete specifications. Explains how valve works to provide automatic shut-down of turbine, compressor or engine in event of overspeeding and to prevent flywheel explosions. Golden-Anderson Valve Specialty Co.

106 125-Lb SP Valves — Design and construction features of a line of 125-lb pressure globe, angle and check bronze valves are described in Circular 582. Featuring large sectional illustrations, gives dimensions of these valves which are used for pressure ratings of 125 lb steam service, 200 lb water, oil and gas. The valves are equipped with company's non-slip handwheel. The Lunkenheimer Co.

107 Pressure Regulating Valves — Twelve-pp Bulletin S-22-CA describes pressure regulating valves and pressure master controls. Profusely illustrated with photos, cutaways and sectional views, bulletin describes diaphragm-operated spring-opening and spring-closing regulating valves, pressure controllers, air locks, valve positioners, and selector panels. Includes specifications. The Swartwout Co.

108 Disc-Type Valves — Bulletin 1000 is a 16-pp catalog providing illustrations, operating and circuit diagrams, and dimensions and weights of manufacturer's full line of valves. These are valves embodying disc-type construction and used for operating air and hydraulic cylinders, single and double acting, and air motors; available in hand-, foot-, power- and solenoid-operated models. Ledeen Mfg. Co.

109 Pinch Type Valves — Catalog FL 382, 28 pp, presents a line of pinch type flexible valves described as particularly adaptable to sand and water solutions, abrasive and corrosive fluids, other hard-to-handle materials. Explains construction, stresses advantages of these valves and gives detailed data on both hand- and diaphragm-motor operated types. Includes selection information, installation and mounting diagrams, charts of construction material recommendations. Farris Flexible Valve Corp.

110 Impulse Steam Traps — High capacity impulse steam traps for extra large volumes of condensate are the subject of Bulletin T-1745. Explains performance of trap; gives capacity data, construction materials and dimensions and prices. Yarnall-Waring Co.

ELECTRICAL

111 Low Voltage Circuit Protection — Five types of low voltage air circuit breakers (600 v a-c, 250 v d-c) with interrupting ratings from 15,000 to 100,000 amp, are presented in Bulletin GEA-5915, 12 pp. Stresses reliability, safety and easy maintenance of these circuit breakers and shows, in step-by-step photos, how easily they are installed. Special features of each type explained. General Electric Co.

112 Isolators — Air interrupter and cable isolators designed for economy, compactness and safety in interruption in applications through 15 kv are described in 12-pp Bulletin 138. Includes dimensions, ratings, data on terminals, mounting details. Electrical Engineers Equipment Co.

APRIL, 1953
Card void in 6 months

POWER ENGINEERING

Please have the manufacturers send me without obligation information or bulletins indicated by the numbers circled below.

Name ..... Title .....

Company Name .....

Company Address .....

City ..... State .....
(If you prefer delivery at home, give home address, too)

Home Address .....

City ..... State .....

| Equipment | Helpful Bulletins | | |

113 Feed Pump Motors — Large induction motors of 3600 rpm, 1000 hp and larger, are presented in Bulletin GEA 5813. Illustrated by photos and cutaway drawings, covers design and engineering advantages of these boiler feed pump motors. Includes helpful information on motor selection, dimensional data. General Electric Co.

114 Motor Controls — In this 28-pp bulletin the most important items in company's line of standard motor control apparatus for all industries are presented. Controls, starters and accessories are described and their applications listed. A feature of the book is a section showing what goes on behind the scenes in the manufacture of the controls. Allen-Bradley Co.

115 Electrical Tapes — This 8-pp booklet presents applications of seven paper-backed electrical tapes in electric motor, coil, and transformer construction. Shows how purified crepe- and flat-paper tapes can be used to insulate motor field coils, to anchor lead wires and to insulate coil windings from the core, and how purified paper tapes with thermosetting adhesives can be used where higher temperatures are incurred. Also describes a high-tensile strength tape. Physical and electrical properties, electrolytic corrosion factors listed. Minnesota Mining & Mfg. Co.

The Reader Service Card below needs no postage. Just circle item numbers of all bulletins wanted, fill in name etc., detach and mail.

116 Carbon Brushes for FHP Motors — Catalog 61 is a 66-pp carbon brush data book for fractional horsepower motors giving complete information on brush replacement. Indexed, well illustrated and easy-to-use, this book lists replacement brushes under the appliance manufacturer's name as well as under the motor manufacturer's name. Becker Brothers Carbon Co.

117 High-Capacity Fuses — Form HCS, 6 pp, describes fuses of unlimited interrupting capacity on voltages to 600, designed to afford protection for loads of 600 to 5000 amp. Explains how high speed operation on heavy shorts limits current to safe values; how fuse minimizes equipment damage, reduces dangerous stresses in transformers, and protects inadequate circuit breakers. Includes test data, charts on opening time, current limiting effect. Bussmann Mfg. Co.

MECHANICAL POWER TRANSMISSION

118 Gear Speed Reducers — Catalog 47-B, 80 pp, presents ordering and application information on motor reducers, gear speed reducers, and horizontal and vertical drive motorized gear speed reducers. Gives service factor classifications, selection tables and price lists, data on overhung and thrust loads and dimensions and weights. Special features of the line are described briefly, typical applications pictured. D. O. James Gear Mfg. Co.

119 Flexible Gear Couplings — Sixteen-pp Catalog C-4 introducing company's new flexible couplings shows how their design offers more horsepower with less weight and size, easy assembly, and other advantages. Typical applications are pictured. Specifications on five regular types and several special types are provided and engineering data included. The Sier-Bath Gear and Pump Co., Inc.

120 High Capacity V-Belts — Belts for tough jobs are the subject of Bulletin 20B7786. Shows how they carry greater horsepower rating, are oil resistant and static conducting. Stresses application of these belts for use in tight spots, for changed peak loads, for cutting sheave costs and for use where static is a factor. Allis-Chalmers Mfg. Co.

121 Motors and Gear Motors — This 10-pp catalog includes specifications and illustrations of company's synchronous and non-synchronous instrument motors and Series 500 gear reduction motors and temperature controls, complete with rating charts and mounting dimensions. Gleason-Avery, Inc.

LIGHTING, COMMUNICATION

122 Fluorescent Luminaires — Booklet B-5799, a 24-pp pocket size catalog of fluorescent luminaires gives detailed descriptions accompanied by photos and diagrams of each luminaire. Tells where the respective types are best applied, what models are available, features of each and dimensions. A 4-pp table gives standard data, prices, on all luminaires. Westinghouse Electric Corp.

123 Fluorescent Lamp Ballasts — Sixteen-pp Bulletin GEA-4950E on fluorescent lamp ballasts contains photos and wiring diagrams of the equipment, gives specifications of switch-start, trigger-start, slimline, circline, germicidal and d-c operation ballasts. Also, ballasts for instant-start lamps, series ballasts with sequence starting, multiple use of slimline ballasts, and high voltage lighting are explained. Problems of frequency, operating temperatures, noise, moisture are also noted. General Electric Co.

124 Audio-Radio-Television Electronics — This 24-pp booklet gives design features, specifications and prices of company's line of amplifiers, public address systems, television boosters and allied equipment. Also describes a variety of specially designed sound and intercommunication systems to meet individual requirements of industrial plants and institutions. David Bogen Co., Inc.

125 System-Wide Telemetering — Bulletin GEA-5746, 8 pp, covers a line of system-wide telemetering equipment. Profusely illustrated, describes design features, performance, circuits, applications and advantages. Gives information on telemetering transmission channels, including carrier-current, microwave, wire-line, and a diagram of company's Type TF equipment in a standard power transmission system. Points out that this telemetering equipment is available as a co-ordinated system. General Electric Co.

126 Retractile Cords — This 8-pp bulletin presents retractile cords for general communication and power applica-

(Continued on page 131)

BUSINESS REPLY CARD
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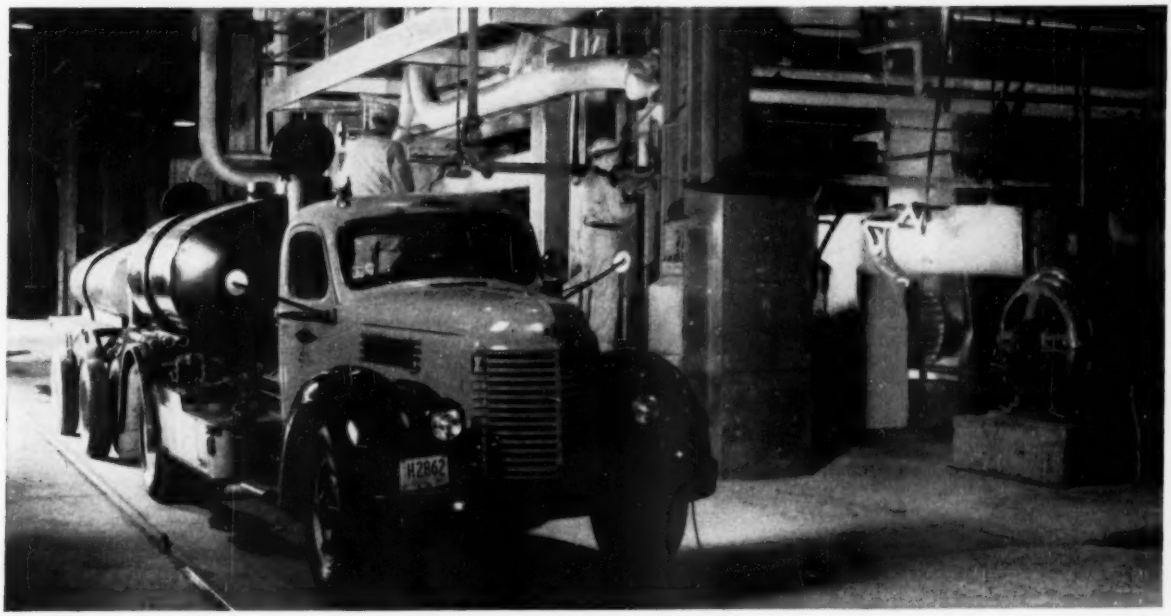
BOILER CLEANED CLEANER BY DOWELL SERVICE

Chemical solvents removed 1650 lb. of deposits from boiler previously "cleaned" by turbining



When you consider that liquid chemical solvents will reach wherever water will flow, you can soon appreciate the many advantages of cleaning with chemistry.

Where mechanical devices, rattling, and turbining fail to clean—in crevices, around angles, through openings—Dowell solvents are designed to dissolve and loosen scale and sludge . . . carry away these profit-stealing deposits quickly and easily.

For example, Dowell recently cleaned a 150,000 pphr boiler that had previously been turbine-cleaned. Although the chemical cleaning required only a few hours, Dowell engineers removed 1,650 *additional* pounds of deposits from the boiler. Best of all, no scaffolding or dismantling of equipment was necessary. Dowell-designed equipment was used to introduce special liquid solvents through regular connections. Downtime was kept to a minimum.

What is *your* cleaning problem? Dowell has extensive experience in cleaning all kinds of process and heat exchange equipment. Dowell furnishes trained personnel, pump trucks, and control equipment.

Dowell engineers apply liquid solvents according to the technique demanded by the job: for example, by filling, spraying, jetting, cascading or vaporizing.

For further details or estimates, call your nearest Dowell office or station. Or write to Tulsa, Dept. J-24.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

Chemical Services for Oil, Gas and Water Wells

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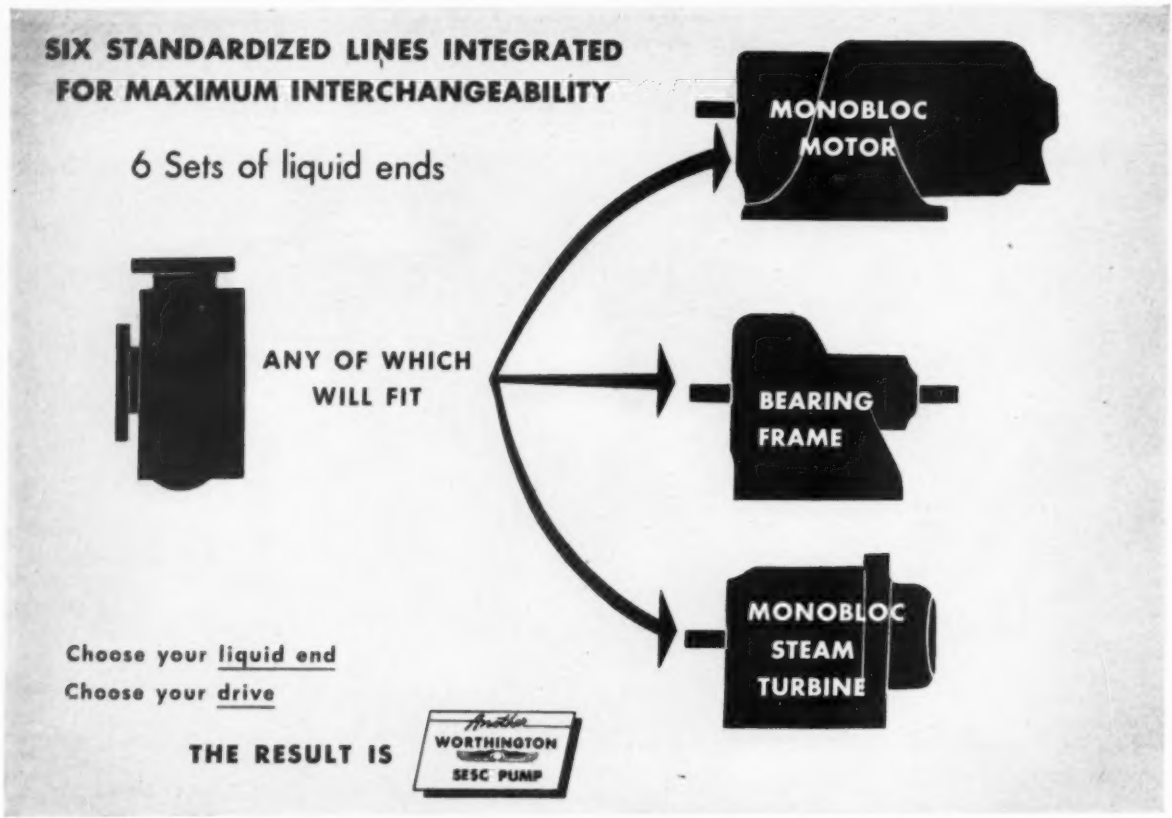
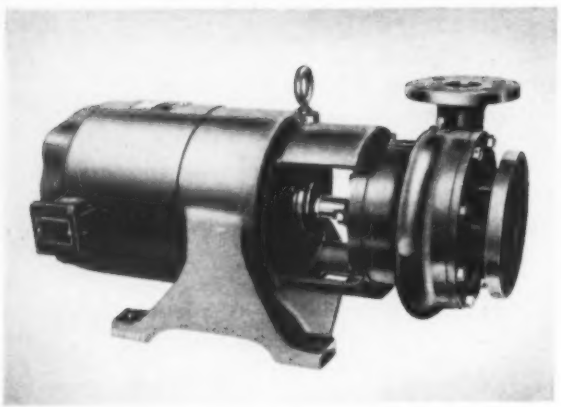
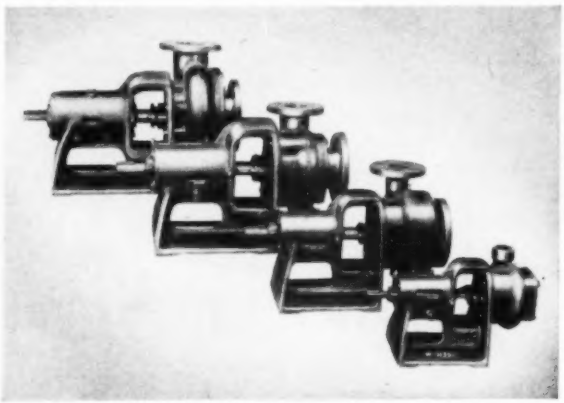
How Worthington makes



WORTHINGTON STANDARDIZATION assures you the one *right* pump for every job. Most "specials" can be assembled from standard parts and shipped to you without delay.



THE WORTHINGTON MONOBLOC, the pump with a built-in motor, has long been famous for its compact, streamlined design. It handles many different jobs because it uses any of the six liquid ends that are interchangeable and can be equipped with either conventional packing or mechanical seal.



FRAME-MOUNTED PUMPS use the same rugged mounting as the monobloc units and the six liquid ends fit in four frame sizes. Like the monoblocs, they use a standardized mechanical seal that can easily be changed in the field if necessary. They'll take any kind of drive readily available.

standard pumps do special jobs

Worthington's SESC* line provides for "custom" assembly from standardized parts with standardized mountings, materials and dimensions to give you exactly the centrifugal pump you need

When you order a Worthington centrifugal pump you get the one *right* pump for the job without compromise, without long delays and without paying a premium for a pump to meet "special" requirements.

Worthington can assure you this, because Worthington can assemble any of 60,000 *different* standard pumps, covering virtually every possible application, from 650 standardized parts. Nearly all *special* pumping needs can be filled with a Worthington *standard*.

Worthington SESC centrifugal pumps are husky and well-built—not flimsy, light-duty units. In fact, users find them of better construction than is usually available in custom jobs at higher prices.

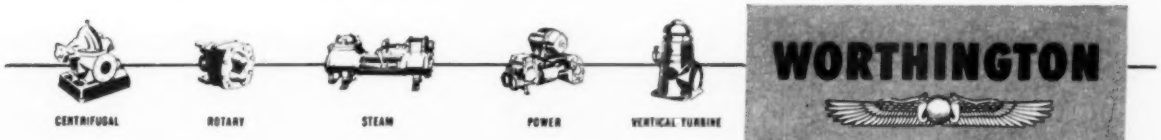
To sum up, you can expect the following advantages when you buy Worthington centrifugal pumps:

- **Greater availability,** since Worthington is equipped to handle more requirements with a *standard* unit.
- **Broader selection** of ratings and special design features.
- **Easier servicing** with lower parts-inventory requirements.

Contact your local Worthington distributor or nearest Worthington district office. Worthington Corporation, Centrifugal Pump Division, Harrison, New Jersey.

*SESC—Standardized End Suction Centrifugal C.2.14

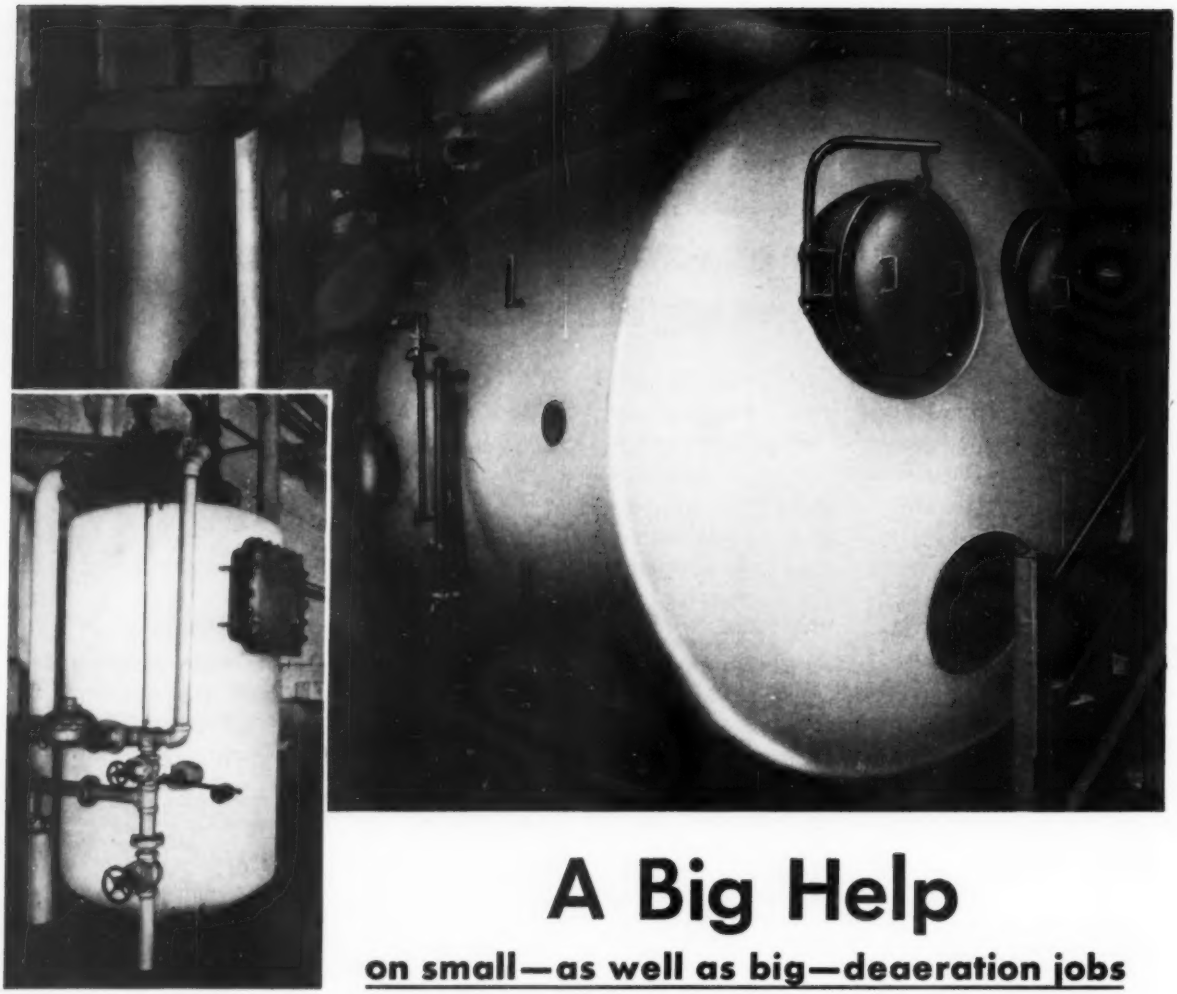
MANY YEARS OF DEVELOPMENT WORK coupled with Worthington's 112-year pumping experience has led to the development of the present Worthington line of centrifugal pumps. This is a view of a section of Worthington's Engineering Department which includes specialists in virtually every field of industry. C.2.14



The World's Broadest Line Assures You The Right Pump For Every Job

WORTHINGTON
Centrifugal Pumps

For more data circle 525 on Post Card



A Big Help

on small—as well as big—deaeration jobs

Small deaerators are big business at Worthington! That's why the plant with small-capacity requirements will benefit by getting acquainted with the complete range of Worthington deaerating equipment.

Worthington Gives You All Types, All Sizes

Worthington deaerating heaters and deaerators are built in sizes to handle from a few thousand pounds an hour to over a million. They are tailor-made to fit the particular requirements of each job. Special designs are available for operation with scale-forming water.

Both tray and steam-jet types are made—with external surface-type vent condensers or internal direct-contact vent condensing. They can be furnished for any practical operating pressure—constant or variable—or for vacuum operation.

With a complete range of sizes and types at their fingertips, Worthington engineers can competently recommend the design best suited to *your* requirements.

Remember, too, Worthington designs are backed by over 50 years experience in the design and manufacture of direct contact feedwater heaters and over 100 years experience in hydraulic machinery.

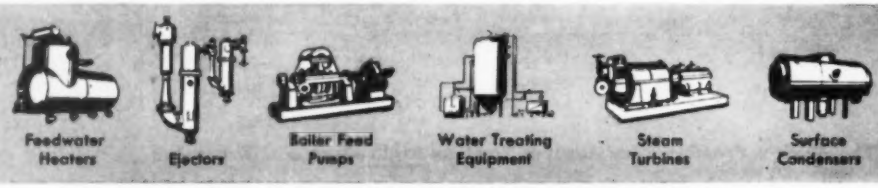
Send your water treating problem to Worthington Corporation, Steam Power Division, Harrison, N. J.

WORTHINGTON

DEAERATORS

S.I.5

A GREAT TEAM IN STEAM



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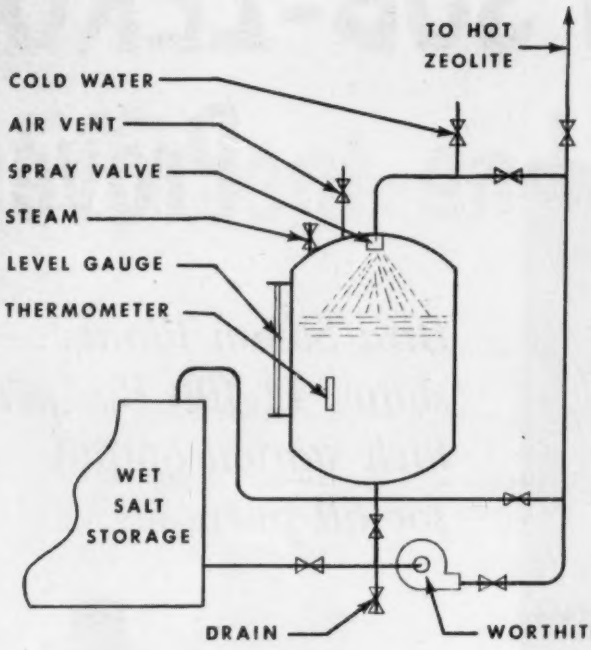


SEQUENCE OF OPERATION OF WORTHINGTON'S HOT-Z REGENERATING SYSTEM*

1. To initiate service, gradually raise zeolite to operating temperature by regulating steam supply to injection water.
2. Return excess water to wet salt storage or discharge through drain.
3. Fill heater storage with saturated brine to desired level.
4. Recirculate until operating temperature is reached.
5. Deliver measured, heated and deaerated brine to zeolite.
6. Return excess brine to wet storage for resaturation.
7. To cut zeolite out of service, inject fully heated water and gradually reduce temperature by regulating steam supply.

*patent applied for.

MAXIMUM LIFE FROM ZEOLITE

How Worthington's Hot-Z Plant protects Zeolite by maintaining uniform temperature during regeneration

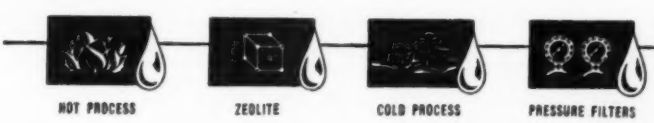
Another feature to check into when you're choosing Hot-Z treating equipment: *the regenerating system.*

For maximum life of the zeolite, two requirements should be met. 1. *A uniform temperature* should be maintained while regenerating the zeolite: that is, the regenerant solution should be held at essentially the same temperature as the water under treatment. 2. When putting a softener into or out of service, the temperature of the zeolite should be raised or lowered *gradually.*

Worthington has accomplished this dual objective with a brine deaerating heater for regenerating the hot zeolite. Its operation is explained in the diagram and accompanying caption. Deaeration is desirable to retard corrosion which might be caused by oxygen in the brine.

This heating system is just one of several exclusive features you'll find in every Worthington Hot-Z system. Remember, too, that Worthington makes all of the major types of water conditioning systems. Let us study your problem and recommend the most suitable solution. Write, stating service conditions in detail, to Worthington Corporation, Water Treating Division, Harrison, N. J.

J.2.3



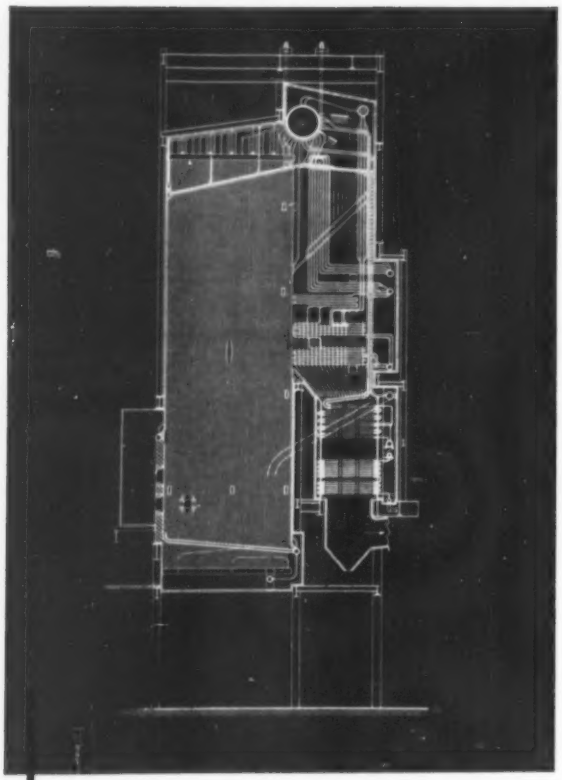
Worthington Makes More of the Equipment for ALL Types of Water Conditioning Systems

WORTHINGTON

Water Conditioning

For more data circle 527 on Post Card

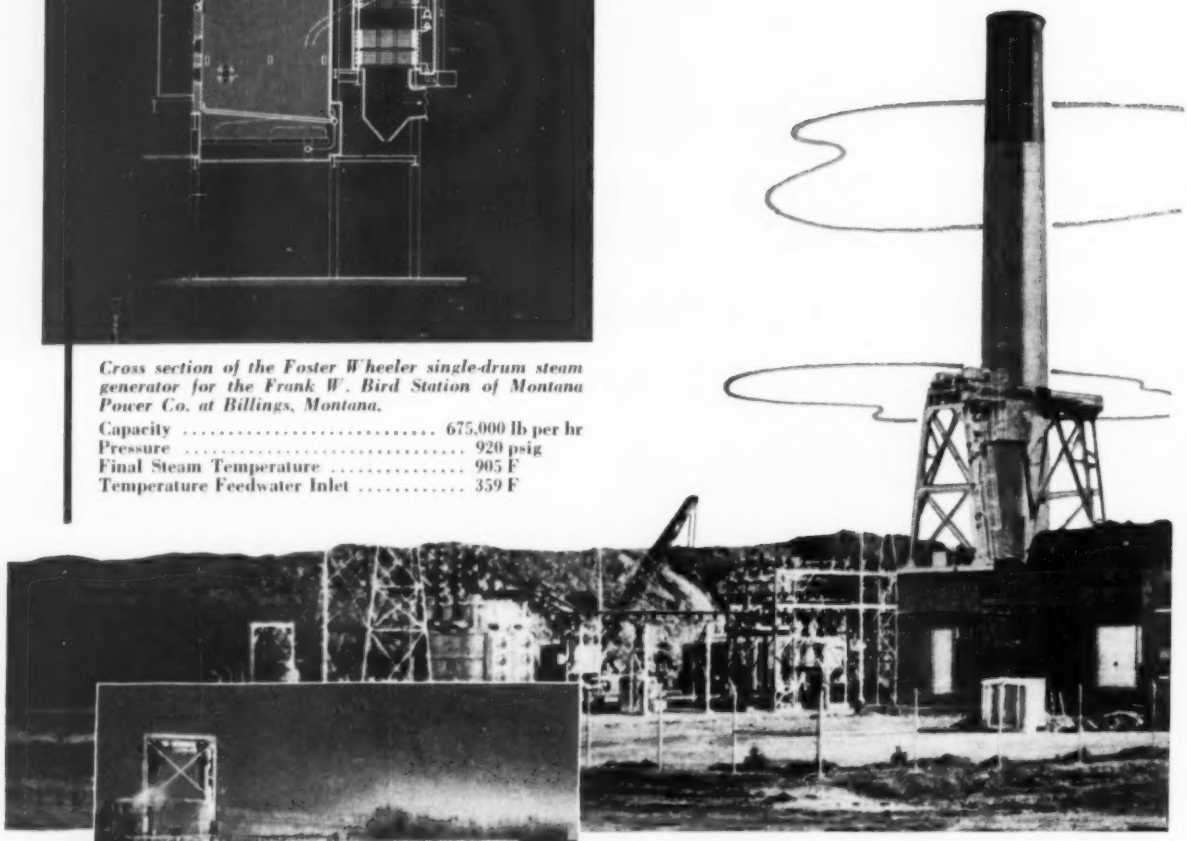
"Operation SUB-ZERO" Proves

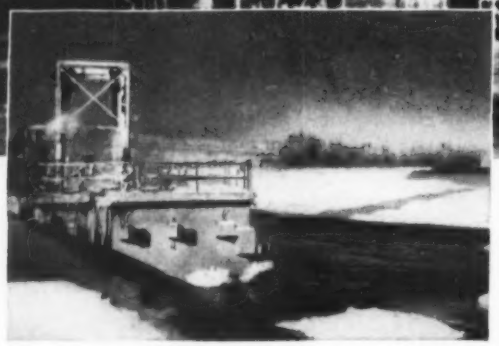


Cross section of the Foster Wheeler single-drum steam generator for the Frank W. Bird Station of Montana Power Co. at Billings, Montana.

Capacity	675,000 lb per hr
Pressure	920 psig
Final Steam Temperature	905 F
Temperature Feedwater Inlet	359 F

Bird Steam Plant shows 11,400 Btu per kwh station output for all purposes

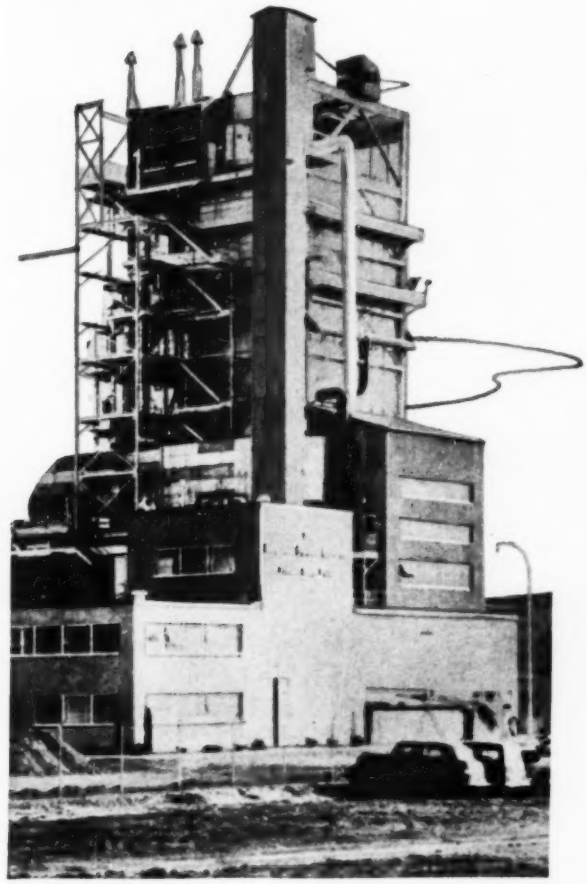




Circulating water intake showing severe conditions of winter operation.

Efficient and Economical

Under the severe operating conditions of temperatures as low as —40F at an elevation of 3100 feet, this semi-outdoor plant of the Montana Power Company engineered by Ebasco Services Inc., has proved efficient and economical in operation and construction. Here are the facts:



HIGH STATION EFFICIENCY

During October 1952, with a metered daily average kwh output of 65,917, the fuel burned for a day consisted of 1,464 bbl of oil, plus 7,630,536 cu ft of natural gas. The oil provided 6,400,000 Btu per bbl, the gas 1,140 Btu per cu ft. Total Btu for all purposes per kwh station output was 11,400.

OPERATED ABOVE RATED CAPACITY

Although normal load condition did not require regular operation above 600,000 lb steam per hour and 60 megawatts, load was picked up to 705,000 lb steam per hour and 76 megawatts in fifteen minutes and carried for two hours.

MINIMUM PERSONNEL

Efficiently operated by only 4 men on each 8-hour shift.

CONSTRUCTED COST

Complete cost, on the basis of 66,000 kw, was approximately $87 per kw.

Once again, the operating facts of an installation indicate the ability of Foster Wheeler to design and fabricate power-producing equipment to meet your needs.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, N. Y.

FOSTER WHEELER

For more data circle 528 on Post Card

You can maintain more of the

Zurn LPD Duplex Plug Type Strainers in common with other types provide continuous flow of liquids and are designed for suction or pressure installations. They are provided with an air-pressure relief valve to prevent air lock in chamber. Zurn Engineered LPD Strainers are designed to provide the answer to costly shut downs.
Plug Relieving Yoke assures easy valve operation since the plug can be unseated before turning.
C washer and yoke cover closures facilitate rapid cover removal for cleaning.
ZURN
engineered
LPD STRAINERS
Zurn LPD Strainers permit high rates of flow with remarkably low pressure drop and immeasurably improve the handling of fluids such as oil, chemicals, water through pipe lines.
Minimum open area ratio of 6 to 1 maintained even though selected basket material may be only 30% open.
Eccentric location of baskets creates a flow cross-section proportional to the flow at all points in the screen cavity, thus reducing turbulence and flow resistance at that critical point.

Copyright 1953

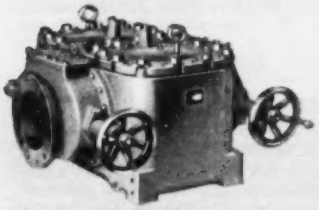
Full-Rated Pressure with . . .

ZURN Engineered Low Pressure Drop LPD STRAINERS

Zurn Low Pressure Drop (LPD) Strainers are design improved for correct circularity. They have ample waterways; smooth inner walls; correctly sized and perforated baskets, eccentrically positioned, all of which combine to reduce pressure loss and afford maximum protection for all types of mechanical units connected with pipe lines. Zurn LPD Strainers are held to close tolerances for materials, shapes, and dimensions, assuring the utmost in strength and safety and continuous operation.

Zurn LPD Strainers are widely used to protect close-tolerance control devices and delicate mechanisms, also to protect product purity. They make continuous production processes possible. Zurn Fluid Handling Engineers are available for consultation on your particular problem.

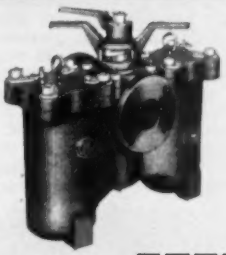
There is a ZURN LPD Strainer for every fluid handling purpose



Zurn Duplex Gate Type Multi-Basket Strainer.

Zurn Sinlex Strainer. Available in offset and straight-through types.

Zurn "Y" Type Strainers available in any cast material and for high pressures.



Zurn Duplex Plug Type Strainer.

Zurn LPD Strainer applications include fluid handling lines for lubricating and fuel oil, and oil during the refining process; a wide range of chemicals produced and used by the various process industries; public utility power plants; power stations; industrial plants; ships and high temperature installations. Zurn Fluid Handling Engineers are available for consultation.

Pat. & Pat. Pending

J. A. ZURN MFG. CO.

INDUSTRIAL DIVISION • ERIE PA., U. S. A.
In Canada: Canadian Zurn Engineering Ltd., Montreal, 25, P. Q. Canada

Write for LPD Strainer Manual Data No. 952.

This manual includes previously unpublished pressure drop data and gives useful, factual information on fluid handling.

J. A. ZURN MFG. CO.

Industrial Division, Erie, Pa., U. S. A.

Please send me Zurn LPD Strainer Manual Data No. 952.

Name_____

Position_____

Company_____

Street_____

City and State_____

Please attach coupon to your business letterhead—Dept. PE

For more data circle 529 on Post Card

Equipment News

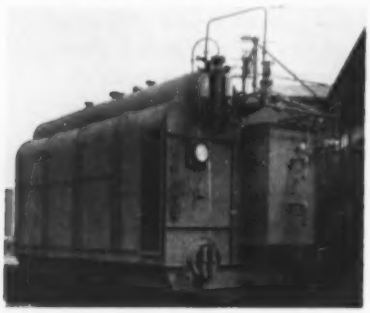
SUMMARIZED HERE are new products and improved ones . . . recent developments of leading manufacturers who will gladly supply further information at no cost. You may use the no-obligation, postage-free cards on pages 37 and 131 for your request. Just circle numbers of the items you'd like to know more about

1—STEAM GENERATORS

Packaged unit water tube boilers, ready for installation

Enclosed in an insulated sectional steel casing, one of these units requires only a foundation and necessary piping, duct and electrical connections to place it in operation. The unit is a two-drum longitudinally fired boiler, its furnace formed by equally-spaced U tubes rolled into the steam and mud drums to eliminate the necessity of side wall headers. A 36-in. steam drum and 24-in. mud drum are standard.

Available in both induced draft or forced draft design, the generators burn natural gas or fuel oils or a combination



of both. They're made in pressures for steam generating capacities to 30,000 lb per hour. Soot blowers and superheaters can be accommodated. The generators are declared suitable for indoor or outdoor installation, can be shipped by rail (as shown) or by truck. The Henry Vogt Machine Co.

2—PACKAGED WATER CHILLER

Simplifies installation and helps to reduce air conditioning costs

This "cold generator" is expected to contribute to lowering both cost and upkeep of medium-sized air conditioning systems. It is designed to provide a single-unit source of large quantities of cold water for air conditioning and refrigeration systems requiring between 10 and 15 tons of cooling. The self-contained unit requires only water and electrical connections for installation.

Installation savings are accomplished by combining compressor, condenser, liquid cooler, controls, motor and accessories in a single factory-assembled unit. Savings in upkeep and operating costs are credited to the unit's basic design and to the use of company's multistep reciprocating compressor. Power and water consumption is automatically adjusted to the demand for cooling in regular stages.

The chiller will be made in six sizes with capacities from approximately 10 to 50 tons of refrigeration for use in both air conditioning installations and industrial processing. It is described as particularly well suited where varying demands for cooling of different spaces are met by the unit in systems which circulate chilled water in summer, and hot water or steam in winter to individual air conditioning units. The Trane Co.

3—CENTRIFUGAL PUMPS

Close coupled, motor driven, for pumping up to 70 gpm

The Model B Pumps are made in two sizes, 1 in. and 1¼ in. discharge, and will pump up to 70 gpm, heads to 110 ft. The pumps are designed for economy, performance and compactness. They incorporate mechanical shaft seals, stainless steel shafts, enclosed bronze impellers and heavy duty ball bearings. They are close-coupled to continuous-duty jet pump motors.

These pumps are suggested for general service or as integral parts of air conditioning units, cooling towers, hot water circulators. Bulletin 211 describes them in detail. Carver Pump Co.

4—QUICK-ACTING VALVES

Cylinder operated may be actuated by air or other fluids

These valves can be regulated for operation at any speed, and can also be remote controlled electrically or manually. They are designed to permit automatic cycle operation and multiple operation by one man. The valves have straight-through flow and drop tight seal, and are applicable wherever quick opening and closing is desired. Everlasting Valve Co.

5—OIL SEAL

For use on electrical cable splices, adheres to many surfaces

The Harvel Oil Stop is claimed to provide an absolute oil seal on cable splices where oil pressure is encountered, acting as a binder between layers of insulating tape and sealing against pressure and moisture. Labor savings are reported, since only one splice per conductor is required. And on low voltage terminals and indoor terminals, this Oil Stop eliminates a pothead, it is stated.

The seal is said to remain oil tight indefinitely, because it cures without application of heat to and infusible state.

It adheres to rubber, oil-impregnated paper, varnished cambric tape, fiber, Bakelite and copper. A booklet of directions on use of the seal is offered. Irving Varnish and Insulator Co.

6—TOUGH PLASTIC COATING

Serves as both protection and color identification for insulated piping

Insulcolor is a tough plastic coating for insulated refrigerant, cold water, steam and other lines and insulated equipment. It can be brushed or sprayed on. It will withstand temperatures to 160 F without cracking, shrinking or crazing, manufacturer says, and it may be used over heat insulations, cork pipe covering and lagging, and also as a finish over cork-insulated air conditioning ducts.

Insulcolor comes in white and six colors — light and dark green, light and dark blue, yellow and buff. The coating can be applied over standard asphaltic finishes without bleeding through, it is noted, and the tough finish resists bumping and abrasion.

Several other advantages are announced for Insulcolor, including high water resisting properties which make it suitable for inside or outside use. No inflammable solvents are used in it, and when dry it is classified as fire-retardant. Also, its smooth surface can be readily washed off. Base white Insulcolor and the color tint are shipped in separate containers. Armstrong Cork Co.

7—FIELD RHEOSTAT

Motor operated, designed for ease of installation, maintenance

The Type RK Rheostat is used to adjust speed of d-c motors to 200 hp and voltage of generators to 300 kw. The rheostat uses snap-action limit switches. Two cam-operated switches are supplied with each unit with additional switches available for auxiliary circuits. Each cam is adjustable over a 360 deg range from the front of the rheostat, and is available for 15-, 45-, and 90-deg travel.

Two gear ratios can be supplied: one permits full rheostat travel in from 5 to 15 sec; the other, full travel in 15 to 45 sec. Travel time can be adjusted over a 3-to-1 range by inserting resistance in the motor circuit. The drive mechanism mounts on the front panel, up to three standard rheostat plates can be mounted on the rear of the panel, and all components are readily accessible. Westinghouse Electric Corp.

8—FLOW METERS

Are designed to indicate flow rates of air and industrial gases

This new line of flow meters includes 11 different sizes; each meter having its own built-in calibration for the specific gas and rate of flow to be measured. Measurements are easily read, it is noted, because the oil in the glass tube not only dampens pulsations, but also prevents accumulation of dirt or foreign matter that might obscure the reading. The meters have but one moving part. They are designed for panel mounting,

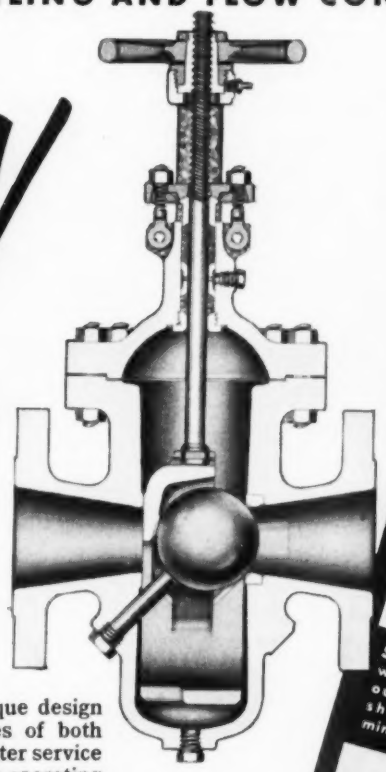
FOR SEVERE THROTTLING AND FLOW CONTROL SERVICES . . .

NEW

CRANE-PAUL
Venturi-Ball
VALVES

(Patented and Patents Pending)

CAST STEEL OR CRANE 18-8Mo ALLOY
Outside Screw and Yoke—Flanged. Available with sliding stem for assembly with power operators.



Fully closed with ball disc locked in outlet port. Ball seldom seats in same position, thus minimizing wear and erosion.
Smooth opening begins when ball cage "rolls" ball out of its seat. Crescent shape opening permits minute throttling.
Inclined surfaces in the cage lift the ball disc clear of the seating surface.
Fully opened with U-shaped bottom of cage bridging the gap in body to form a continuous flow passage.

Meet the Crane-Paul Valve—a unique design that combines desirable advantages of both gate and globe valves. It provides better service and longer life under more rigorous operating conditions than such valves normally stand. These features include—

Exceptionally accurate throttling with a minimum of wear and erosion, resulting in long-lived seating surfaces.

Straight-through, non-turbulent flow—with pressure drop characteristics approaching those of venturi-type gate valves.

Smooth, easy response throughout the entire range of operation.

Completely tight shut-off.

Heart of this new Crane-Paul Valve is a precision-ground ball disc which rides loosely in a cage direct-connected to the valve stem. In operation, the ball is moved to and from the center of flow and rolls into and out of the body seat. At no time during valve operation does the ball spin or chatter, even in closely throttled positions. It revolves just enough to provide a new seating surface each cycle. In the closed position, part of the ball actually protrudes into the outlet port where it is tightly seated by the wedging action of the ball cage.

Literature Sent on Request

Full information on this new Crane-Paul Valve is in your Crane '53 Catalog. Literature is available from your Crane Representative or on request to address below.

Cast Steel
150-Pound, Sizes 1 through 6"
300-Pound, Sizes 1 through 8"
600-Pound, Sizes 1 through 4"

Crane 18-8Mo Alloy
150-Pound, Sizes 1 through 6"
300-Pound, Sizes 1 through 8"

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

For more data circle 530 on Post Card

but if panels are not used, standard brackets are available for single, double or triple mounting.

A tab affixed to the bottom of each meter indicates in red letters the gas being measured. The meters are available for measuring dissociated ammonia, propane, exothermic cracked (rich and lean), air, natural gas, ammonia, butane, nitrogen and other gases. Bulletin 201 gives detailed information. Waukee Engineering Co.

9—INSULATING BLOCKS

For high temperature insulation, produced by new process

Supertemp PV (pressure vacuum) Insulating Blocks are declared suited for temperatures up to 1900 F and said to be an improvement over many mineral wool insulating blocks. According to manufacturer, these blocks withstand higher temperatures, have greater breaking strength and provide greater utility because of their ease in handling. Their light weight offers faster and easier application.

The blocks are produced by special machinery and equipment which combine vacuum and pressure techniques which cause the mineral wool fibers within the block to become felted and compressed. The Eagle-Picher Co.

10—MANUALLY RESET VALVES

Is pressure operated, for use in hazardous locations

The new Bulletin 8035 Valve operates on loss or application of pressure. While not a solenoid valve, in a true sense, it embodies engineering advantages of company's solenoid valves. It is available in two-, three- and four-way construction. Installation of any of these styles is facilitated by three design features: the valves may be mounted in any position, their operating mechanism can be rotated 360 deg, and they can be provided with auxiliary switches for indicating lights and electrical control circuits. Automatic Switch Co.

12—ELECTRONIC DRIVE

Is smaller, simplified packaged variable speed unit

A simplified addition to this company's line of Thy-mo-trol Drives is announced. Designed for use on many types of equipment, including conveyors, variable volume or proportioning pumps, and machine tools, the new packaged electronic unit is available for ¾- to 3-hp drives. Company engineers say it offers stepless speed-control, pre-set speed control, and close speed regulation, and includes the smallest of the Thy-mo-trol Drive Panels, measuring 15 by 18 by 12½ in.

The new drive comes in standard speed ranges of 5 to 1 and 20 to 1, and in both reversing and non-reversing forms. Though less expensive than company's larger systems, it includes dynamic braking and standard overload and undervoltage protection. Speed selection is by means of a single knob.

The simplified system consists of an anode transformer, electronic control panel, control station and d-c shunt-wound motor. It operates on 220/440 v, single-phase 50/60 cycles. Dual rating of anode transformer makes it possible to use either voltage by changing primary connections. General Electric Co.

13—STRINGING DEVICE

Saves time and climbing in the stringing of overhead wires

The Wire Creeper enables linemen to string additional wire through trees, over buildings, across ravines and other troublesome areas, wherever one wire is already in place. The operator puts the Creeper on the wire and, by pulling and releasing the plastic cord attached to it, moves the Creeper along the wire in 10 to 20 ft leaps, it is stated, from one pole to the next in less than a minute. When the Creeper reaches the next pole, the new wire is pulled across by means of the plastic cord.

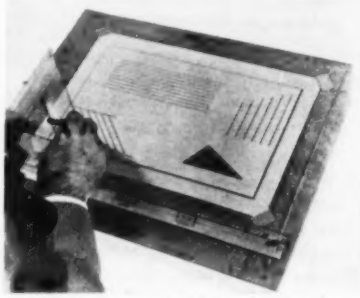
Line splices and frayed insulation are said to be no problem for the Creeper. Trees slow it up a bit, but company says

it goes through twigs and foliage and will travel up steep inclines. For night work, a luminous bottom lets operator follow its progress. Martindale Electric Co.

14—PARALLELING BOARD

Offers several improvements, comes in three popular sizes

For straight line, parallel and angular drawing, only a pencil and triangle are needed with the Par-L-L-er. As the ruler is moved upward or downward it parallels its entire length and the plastic indicator measures the movement. Ruler



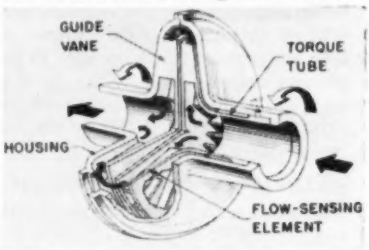
and indicator are held in position by a strong, serviceable cord arrangement.

Special features of this new board include the transparent indicator which measures parallel movement of rule in fractions of an inch. In three sizes, a 15- by 19-in. boards sells for $4.50. A larger size costs $6.50 and a smaller one, $3.25. The Bradford Bailey Co.

15—FLOW METER

Is designed to respond to pounds, yet be insensitive to volume

An instrument capable of measuring the true mass rate of flow of anything that will flow or fall through a pipe is announced. Direct reading measurements



in terms of pounds per minute, or with integration, pounds, can be made on gases, liquids, slurries, or particles in an air stream, all with the same instrument, manufacturer explains, and the accuracy of measurement is completely independent of volume, temperature, pressure, viscosity, compressibility, or external accelerations.

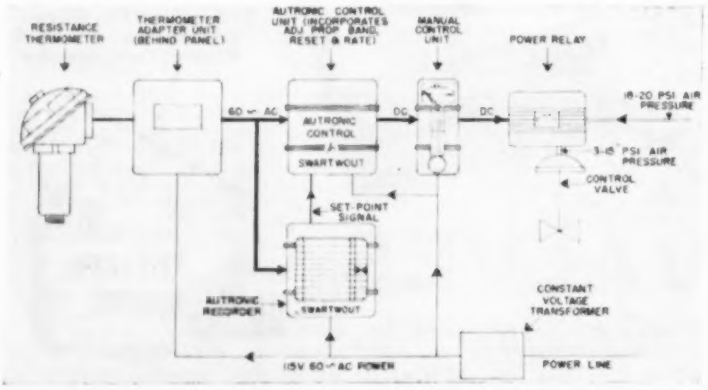
As an example of industrial use, it is noted that two or more units could be used with a proportioning unit to con-

11—TEMPERATURE "PACKAGE"

Is offered for use in automatic controlling and recording applications

Based on units of company's all-electronic Autronic Control System, this package is composed of a new temperature primary element transmitter, controller, recorder, manual control, power relay, and one or more constant voltage transformers depending on the needs of the individual installation.

Among advantages cited are instantaneous and accurate response, unrestricted location of units comprising the system, adaptability to many different processes, interchangeability of components without recalibration, and low initial cost. Engineering details, dimensions and prices available. The Swartwout Co.



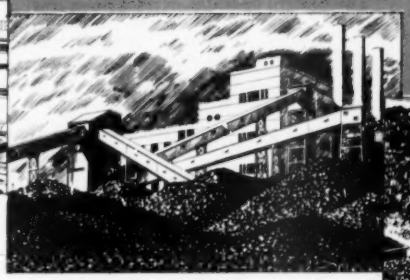
Are you keeping FUEL COSTS as low as you can?

ASK OUR MAN!

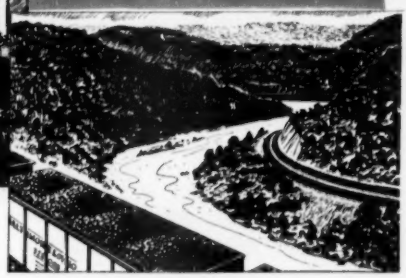
He will demonstrate with *facts* why your best bet is bituminous coal. He will help you find the right kind and size of coal for your specific need; and he will show you up-to-the-minute ways of burning it efficiently and economically.

In Baltimore & Ohio territory, close to industry's doorstep, are bituminous coals in all varieties—for power, coking, steam, heating. Produced in highly mechanized mines, these coals are low in cost and uniform in size and quality. With the modern burning equipment now available, the efficiency and cleanliness of bituminous coal will amaze you!

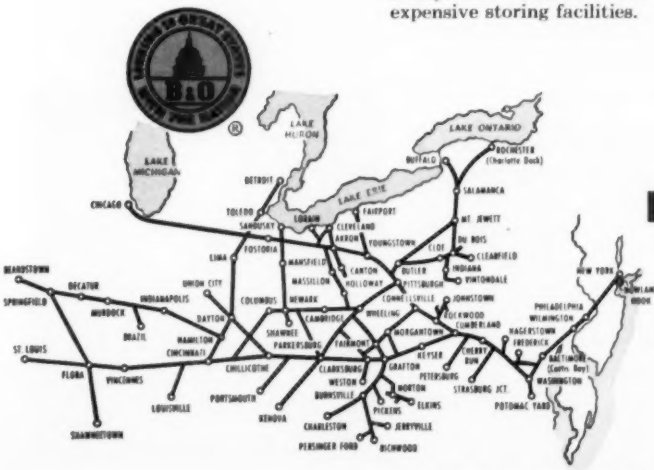
Surprising economy. Conveniently accessible and highly efficient in modern use, bituminous coal from mines on the B&O keeps fuel costs low.



Convenient storage. Bituminous coal can be stored anywhere with safety. This eliminates the need for expensive storing facilities.



Reserves for centuries. Plants built for bituminous coal are assured a continuity of fuel supply regardless of emergencies. On the B&O alone, are reserves estimated at 25 billion tons!



Baltimore & Ohio Railroad

Bituminous Coals for Every Purpose

For more data circle 531 on Post Card

trol any mixture in a process. The operating principle of the meter is simple — measurement is made of the torque necessary to give the flowing mass a Coriolis acceleration. This torque is dependent only on the dimensions of the flow meter, a rotational speed, and the mass flow. Company says models of this mass meter are now in operation, but until flow rates and sizes can be standardized, the meters will be custom built. Control Engineering Corp.

16—GAS BURNER

Pre-mix design, is for the firing of packaged automatic boilers

In the Voriflow Burner gas flows through the central gas nozzle from the gas plenum. Simultaneously, combustion air from the blower enters the air plenum tangentially, automatically controlled by the motor operated damper. Primary pre-mixing air is captured by a stationary air wheel register. This assembly directs the pre-mixing air through holes into the gas nozzle against venturi-shaped air baffles. The air and gas are thoroughly mixed enroute through the gas nozzle. The outer secondary air ring controls the amount of secondary combustion air admitted to the combustion chamber. Here ignition takes place.

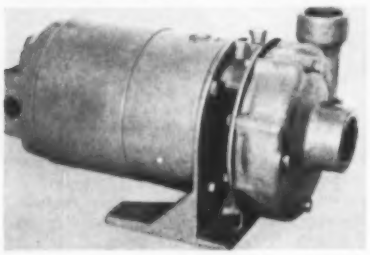
The burner was developed for the firing of company's Powermaster Packaged Automatic Boilers, and all components are sized for the Btu content of the gas to be burned and the heat requirements of the boiler. This burner is described in Bulletin 1218. Orr & Sembower, Inc.

17—CENTRIFUGAL PUMP

Is close coupled, compact unit; for industrial service

The Fig. 3642 Pump was designed and developed with special attention to air conditioning, but its compactness and performance characteristics make it suitable for other industrial applications. It delivers up to 110 gpm and operates at heads to 110 ft. Electric drive motors range from ¼ to 2 hp. Discharge outlets are tapped for 1- or 1¼-in. pipe.

Motor and pump form a single complete unit installed by bolting down and connecting to piping and power. The



single-suction type impeller is statically balanced, threaded directly on the extended motor shaft, and secured by a stainless steel jam nut. The casing is vertically split for inspection and maintenance without disturbing piping connections, and the discharge nozzle can be turned to any of eight positions.

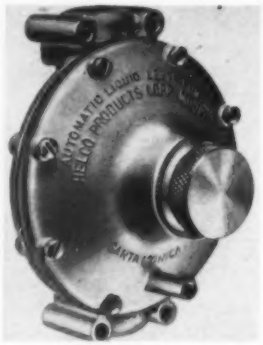
Other features announced for the pump include a mechanical seal which is protected from running dry once the pump is primed, and which prevents leakage, and interchangeable parts which make it possible to convert from one size to the other by changing only the impeller and casing. Bulletin 624A3 describes the pump. Goulds Pumps, Inc.

Want more details on these new products? Use post cards on pages 37 and 131.

18—LIQUID LEVEL CONTROL

Is offered for automatic maintenance of steady liquid level

This new pressure reduction valve is primarily designed to maintain a very low and sensitive outlet pressure. It can be adapted to many uses in diverse types of equipment, according to manufacturer, taking the place of float valves where a closed system is desirable because of sanitary requirements or the



presence of corrosive conditions.

The control operates in inlet pressures from 5 to 260 psi, and can be set to maintain a steady water level in a range from 5 to 20 in. Helco Products Corp.

19—THIRD RAIL SYSTEM

For powering moving cranes, has safety enclosure

The aluminum Keystone System is designed to eliminate the need of improvising structural shapes — such as railroad rails, steel or copper angles, tees, bars or wires — to feed power moving equipment. It is said to offer a design capacity of 1000 amp in a conductor weighing 1/20 that of steel rail-copper booster combinations. Company says it can be used for control and medium amperage conductors and can be applied in parallel to handle currents above normal rating. Electric Service Mfg. Co.

20—POWER SUPPLY

Is battery-operated, for use with direct reading air velocity meter

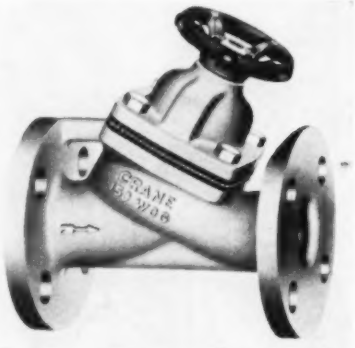
The Power Pack, for use with manufacturer's Air-Meter, offers a reasonably priced air velocity measuring instrument suitable for portable applications. Compact, and ruggedly built, the Power Pack includes a 6 v Hotshot battery and converter to provide 110 v a-c output.

The Air-Meter and Power Pack combination is described as especially advantageous for measuring air velocities at locations where a 110 v supply is not available, including such usually inaccessible places like air conditioning ducts, chimneys and rooftop ventilation fans. Descriptive literature is offered. Hastings Instrument Co., Inc.

21—DIAPHRAGM TYPE VALVES

Packless, are now available in a wide range of materials

The addition of several new body, diaphragm and lining materials to this company's line of packless diaphragm valves is announced. These valves are now regularly available with cast iron,



brass, aluminum, or 18-8 Mo bodies and disc holders; and with diaphragms and disc inserts of Neoprene, Buna-N, and soft natural hard rubber linings. Specially prepared valves for vacuum, oxygen, and acetylene service are also now regularly available.

Outstanding feature of these diaphragm valves is the separate diaphragm and disc construction. Since the diaphragm is not used for seating, it is not subjected to the cutting, crushing and abrasion, company points out, and closure of the independent disc will prevent escape of line fluids even if the diaphragm should fail. Crane Co.

22—PNEUMATIC TRANSMITTER

Miniature type, designed for measuring and transmitting readings

The Series 650 Pneumatic Transmitter is for measuring and transmitting readings of temperature pressure, vacuum, differential pressure, and liquid level to recording, indicating and controlling receivers, including miniature type receivers. Transmission is by air pressures of between 3 and 15 psi that have a direct relation to the measured quantity.

The instrument uses company's standard measuring elements and a simple transmitting mechanism with only one pivot and no flexures, it is explained, and friction and loss motion are practically eliminated. The transmitter is said to be sensitive to extremely small changes in the measured value. The Bristol Co.

User Explains How Armstrong Unit Trapping Boosted Output:

Need for Investment in New Steam Equipment Eliminated by Only $550.00 in Steam Traps

THIS is a story about greatly increased efficiency in a laundry, but the principles involved apply to any plant using steam heated equipment.

In speaking of the benefits derived from Armstrong Unit Trapping, Earl Fast of Soft Water Laundry and Cleaners, Long Beach, California, said, *"It's like a man with dirty eyeglasses—he thinks he's seeing perfectly until he cleans the glasses and finds out what he has missed."*

Mr. Fast's plant modernized its entire return system in 24 hours, installing 71 Armstrong traps costing about $550, with these results:

1. Capacity of machines costing as much as $15,000 per unit increased to the extent that new machines are not now required.
2. Higher quality of ironing and finishing, with touch-up on shirts eliminated.
3. Worthwhile fuel savings.

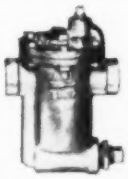
"Our boiler was turning out plenty of steam," continued Mr. Fast, "but we weren't getting the benefit of it. The best power plant in the world is of no value if you don't use its produced steam to maximum efficiency."

And there lies the case for Armstrong Unit Trapping, which discharges air and condensate as fast as it accumulates to keep steam heated equipment hot and producing at a peak rate. Your local Armstrong Representative will be glad to survey your condensate drainage system without obligation. Call him or write:

ARMSTRONG MACHINE WORKS

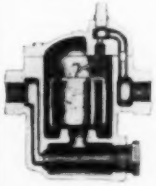
810 Maple Street • Three Rivers, Michigan

Traps with Built-in Strainers Cut Costs



Because the piping at Soft Water Laundry was old, the smallest-sized traps needed protection against dirt and scale. Armstrong No. 880 and 881 traps with built-in strainers were the logical answer because:

1. **They cost less than a separate trap plus a strainer.**
2. **They eliminate external fittings and considerable installation labor.**



Left—Cut-away view showing strainer screen at trap inlet. Strainer can be cleaned without removing or shutting off steam.

You always get more out of equipment when you use Armstrong "Unit Trapping"

FREE
44-PAGE
STEAM TRAP BOOK
Gives Complete Information
MAIL TODAY!

FILL IN AND CLIP TO YOUR COMPANY LETTERHEAD

ARMSTRONG MACHINE WORKS
810 Maple Street, Three Rivers, Michigan

Please send me a Steam Trap Book.

Name .....

Title .....

For more data circle 532 on Post Card

POWER PLANT *Construction News*

Andalusia, Ala. — Alabama Electric Cooperative, Inc., has completed plans for new steam-electric power plant at Gantt, Andalusia, and proposes to begin work in spring. No official estimate of cost announced. Burns & McDonnell Engineering Co., 95th and Troost Aves., Kansas City, Mo., is consulting engineer.

Phoenix, Ariz. — Arizona Public Service Co., Phoenix, will expend about $19,800,000 for extensions and improvements in properties in 1953, including increased generating capacity, power substations, transmission and distributing lines. Of amount noted, approximately $9,500,000 will be expended for work on new Saguaro steam-electric generating plant in Pinal County, to be equipped for a rated output of 200,000-kw, divided into two 100,000-kw units, the first of which is scheduled to be ready for service in June 1954.

East Hartford, Conn. — Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, has approved plans for new boiler house at local plant, with work on superstructure to begin soon. Cost reported over $200,000, with boiler units and auxiliary equipment.

Hartford, Conn. — Connecticut Light & Power Co., 36 Pearl St., through its subsidiary interest, Electric Power, Inc., will expend about $10,000,000 for its proposed new hydroelectric power plant on Housatonic River, vicinity of New Milford, Conn., recently referred to in these columns. Work is expected to begin in near future. Charles T. Main, Inc., 80 Federal St., Boston, Mass., is consulting engineer. Construction award has been made to United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa.

Middletown, Conn. — Hartford Electric Light Co., 266 Pearl St., Hartford, Conn., has taken out permit for construction of proposed new steam-electric generating plant on River Rd., Middletown, previously referred to in these columns, and will begin work on superstructure at early date. It will be 137 x 271 ft. Installation will include turbine-generator, boilers and auxiliary equipment. Cost reported about $3,000,000. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Southbury, Conn. — State Commissioner of Public Works, State Office Bldg., Hartford, Conn., plans installation of new diesel engine-generator unit in power house at Southbury Training School, with complete auxiliary equipment. Cost reported about $125,000. Richard S. Leigh, Main St., Woodbury, Conn., is engineer.

Macon, Ga. — Striefmann Biscuit Co., Trade and Mariemont Sts., Cincinnati, Ohio, crackers, cakes, pretzels, etc., plans boiler house at proposed new baking plant at Macon, where tract of land has been acquired. Cost reported in excess of $1,000,000. Company is an affiliate of United Biscuit Co. of America, 400 West Madison St., Chicago, Ill.

Savannah, Ga. — Savannah Electric & Power Co., 27 West Bay St., plans expansion and improvements in plant and system in 1953, to cost about $16,000,000. A primary feature of projects will include extensions in local Riverside generating station, with installation of new 20,000-kw turbine-generator unit, high-pressure boiler, and accessory equipment. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

New Albany, Ind. — Davison Chemical Corp., Davison Chemical Bldg., Baltimore, Md., industrial chemicals, fertilizer products, etc., plans boiler house at proposed new plant at New Albany. Factory will be used for processing and production of granulated mixed commercial fertilizers. Cost reported close to $1,000,000. Proposed to begin work soon.

Peru, Ind. — Electric Light & Power Dept. has plans under way for extensions and improvements in municipal steam-electric generating station, with installation of new 1500-kw turbine-generator, boiler and auxiliary equipment, estimated to cost close to $2,500,000. Proposed to begin work in spring.

Lockport, La. — Valentine Pulp & Paper Co., Inc., New Orleans, La., recently organized, care of Valite Corp., Whitney Bldg., New Orleans, plans power house at proposed new newsprint mill at Lockport, using bagasse (sugar cane waste) as raw material. It will comprise large group of one and multi-story buildings. Cost reported over $2,600,000. William J. Gibbens, Jr., president of Valite Corp., noted, also will be president of new company.

Rumford, Me. — Rumford Falls Power Co., Rumford, will begin work in spring on proposed new hydroelectric generating plant, previously referred to in these columns. Installation will include two 6400-kw. hydraulic turbine-electric generator units and auxiliary equipment. Cost reported approximately $2,000,000. Charles T. Main, Inc., 80 Federal St., Boston, Mass., is consulting engineer. Company is an interest of Oxford Paper Co., Rumford.

Baltimore, Md. — Consolidated Gas, Electric Light & Power Co., Lexington Bldg., has plans maturing for new steam-electric generating station. Contract has been awarded for structural steel framing, approximating 3500 tons, and work is expected to be placed under way soon. No official estimate of cost announced.

Henderson, Nev. — Engineering Committee, Colorado River Commission, Henderson, is considering construction of new steam-electric generating plant in vicinity of Henderson reservoir. Proposed plant is reported to cost about $21,000,000, including three turbine-generator units and accessory equipment, high-pressure boilers, and auxiliaries. Stearns-Roger Engineering Co., an affiliate of Stearns-Roger Mfg. Co., 1720 California St., Denver, Colo., engineer, has made survey for Commission, recommending new station.

Burlington, N. J. — Public Service Electric & Gas Co., Public Service Terminal, Newark, N. J., will proceed with superstructure for proposed addition to Burlington electric-generating station, previously referred to in these columns, and has made an appropriation of $30,000,000 for program. Installation will include a new hydrogen-cooled turbine-generator and auxiliary equipment to advance plant rating to 475,000-kw; high-pressure boilers and accessory equipment. Completion is scheduled in summer of 1954.

Greensboro, N. C. — P. Lorillard Co., Inc., 119 West 40th St., New York, N. Y., tobacco products, plans boiler plant at new tobacco processing and cigarette manufacturing plant at Greensboro, where tract of 75 acres of land has been acquired. Cost reported in excess of $1,000,000. Proposed to begin work soon. Lockwood, Greene Engineers, Inc., 10 Rockefeller Plaza, New York, is architect and engineer.

Circleville, Ohio — E. I. duPont deNemours & Co., Polychemicals Dept., duPont Bldg., Wilmington, Del., plans boiler plant at new factory at Circleville, to be used for manufacture of plastic film. It will comprise a large group of one and multi-story buildings for general production. Work is scheduled to begin soon. Project will require about 24 mo. for completion and is reported to cost in excess of $10,000,000.

Wickliffe, Ohio — International Paper Co., Container Division, 220 East 42nd St., New York, N. Y., plans boiler plant at proposed new plant near Wickliffe, where tract of about 13 acres of land has been secured. It will comprise a main building, about 63,000 sq ft floor space, equipped for manufacture of paper milk containers. Proposed to begin work soon. Cost reported in excess of $1,000,000.

Kittanning, Pa. — Pennsylvania Electric Co., Johnstown, Pa., has preliminary plans under way for new steam-electric generating station on 60-acre tract of land at Kittanning, with frontage on Allegheny River, recently acquired. New plant will use coal as fuel. Details of capacity and estimates of cost are expected to be made soon.

Anderson, S. C. — American Bakeries Co., 16 Pryor St. Bldg., Atlanta, Ga., bread, cake and other bakery products, plans boiler house at proposed new baking plant at Anderson. Site has been acquired. It will comprise a main one-story building, with traveling ovens and other modern facilities. Cost reported close to $1,000,000. Stevens & Wilkinson, 157 Luckie St., N.W., Atlanta, are architects.

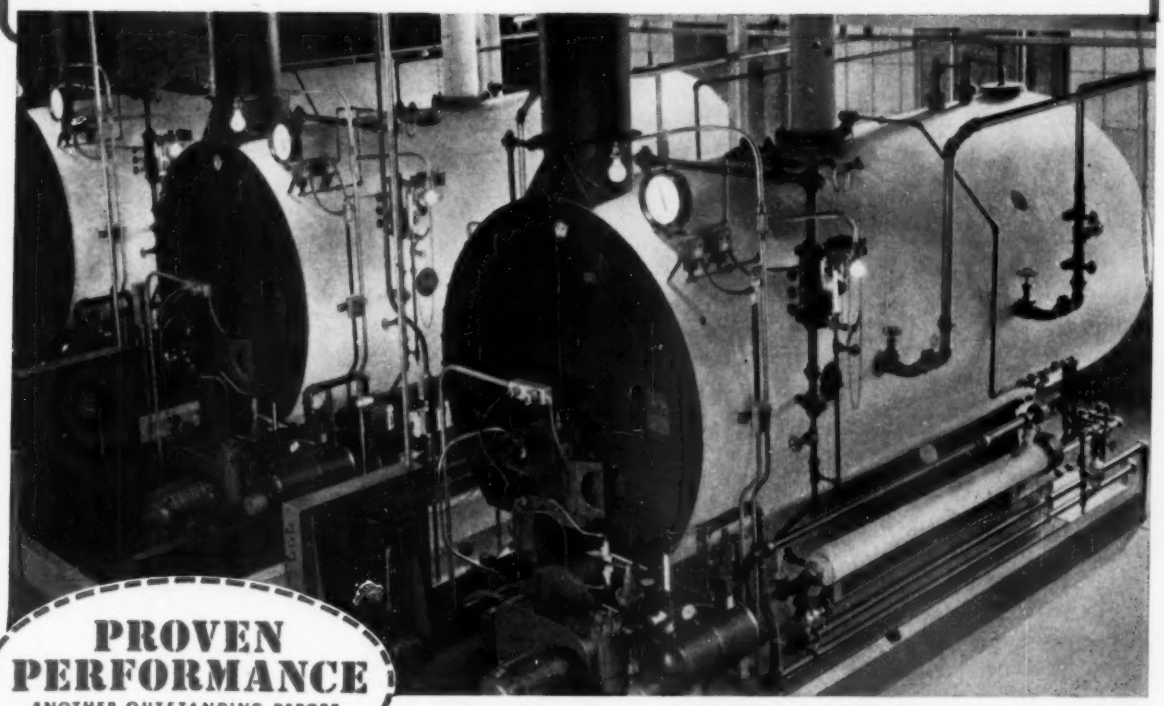
Fulton, Tenn. — Tennessee Valley Authority, Memphis, Tenn., has preliminary plans under way for new steam-electric generating plant on Mississippi River at Fulton (Lauderdale County). It will be equipped for large capacity and is estimated to cost $90,000,000, with turbine-generators, high-pressure boilers, and auxiliary equipment, including power substations, transmission lines and other operating facilities.

Baytown, Tex. — Gulf Alkali Corp., 509 Madison Ave., New York, N. Y., caustic soda, potash, etc., plans boiler house at proposed new chemical plant at Baytown, vicinity of Houston, Tex. It will comprise a series of one and multi-story buildings for processing and general production. Entire project reported to cost about $7,500,000. Proposed to begin work in spring.

Hondo, Tex. — Medina Electric Co-operative, Inc., proposes to construct diesel-electric generating plant on site in vicinity of city instead of steam-operated station, as previously noted in these columns. Installation will consist of diesel engine-generating units, with capacity of $13,500-kw. Entire project will represent a reported investment of about $3,000,000, with transmission lines and other operating facilities. Financing has been arranged through Federal Aid.

Orange, Tex. — Foster-Grant Co., Inc., Leominster, Mass., plastic products, is reported planning boiler house at proposed new branch plant at Orange, where tract of land has been selected. Entire project estimated to cost over $2,000,000. It is understood that work will begin in spring.

Cleaver-Brooks boilers save $25,000 per year for Hoosac Mills...pay for themselves in 2 years' time!



PROVEN PERFORMANCE
ANOTHER OUTSTANDING REPORT FROM A CLEAVER-BROOKS OWNER

After installation and starting service was completed, a check was made on boiler output. Tests indicated efficiency exceeded the guaranteed 80%. After eight months' operation without tube cleaning, stack temperature showed no noticeable gain, indicating high efficiency had been maintained. Planned and installed by Frank I. Rounds Co., Newton Highland, Mass.

INSTALLING 3 Cleaver-Brooks self-contained boilers at Hoosac Textile Mills, New Bedford Division, was a major step in ending boiler worries. Hoosac can count on yearly savings of $25,000, and they're set up for future expansion as well.

Before deciding what type of boilers to install for replacing old, hand-fired boilers, Hoosac carefully considered these factors:

1. **Efficiency of steam generation** — the cost for supplying 12,000 lbs. of steam required each hour at peak capacity for heating and processing.
2. **Saving labor costs** — through safe, automatic operation.
3. **Cleanliness** — important to textile manufacture.

A study of past performance and prominence of similar units in the industry — showed that Cleaver-Brooks self-contained boilers would fill the bill.

Guaranteed 80% thermal efficiency was one of many influencing factors in selecting the 3 Cleaver-Brooks 150 hp. boilers. Even with loads as low as 30% of rating, these boilers operate with a flat 80% efficiency. (Hoosac operates their plant over widely fluctuating loads, particularly in summer.)

That they attained their objectives is borne out by these results — *results which showed the boilers paid for themselves in 2 years' time.*

1. **$15,000 savings in fuel** — fuel cost studies showed 275,000 gals. of oil at 5½¢ per gal. provide steam for a year's operation. Same steam formerly required 2,000 long tons of coal at $15.00 per ton.
2. **$10,000 savings in labor costs** — fully automatic operation minimized boiler maintenance. Personnel were then available for productive plant work.
3. **Cleanliness** — modern boiler room proved more efficient than previous cluttered arrangement. Hand firing, removal and disposal of fly-ash was eliminated.

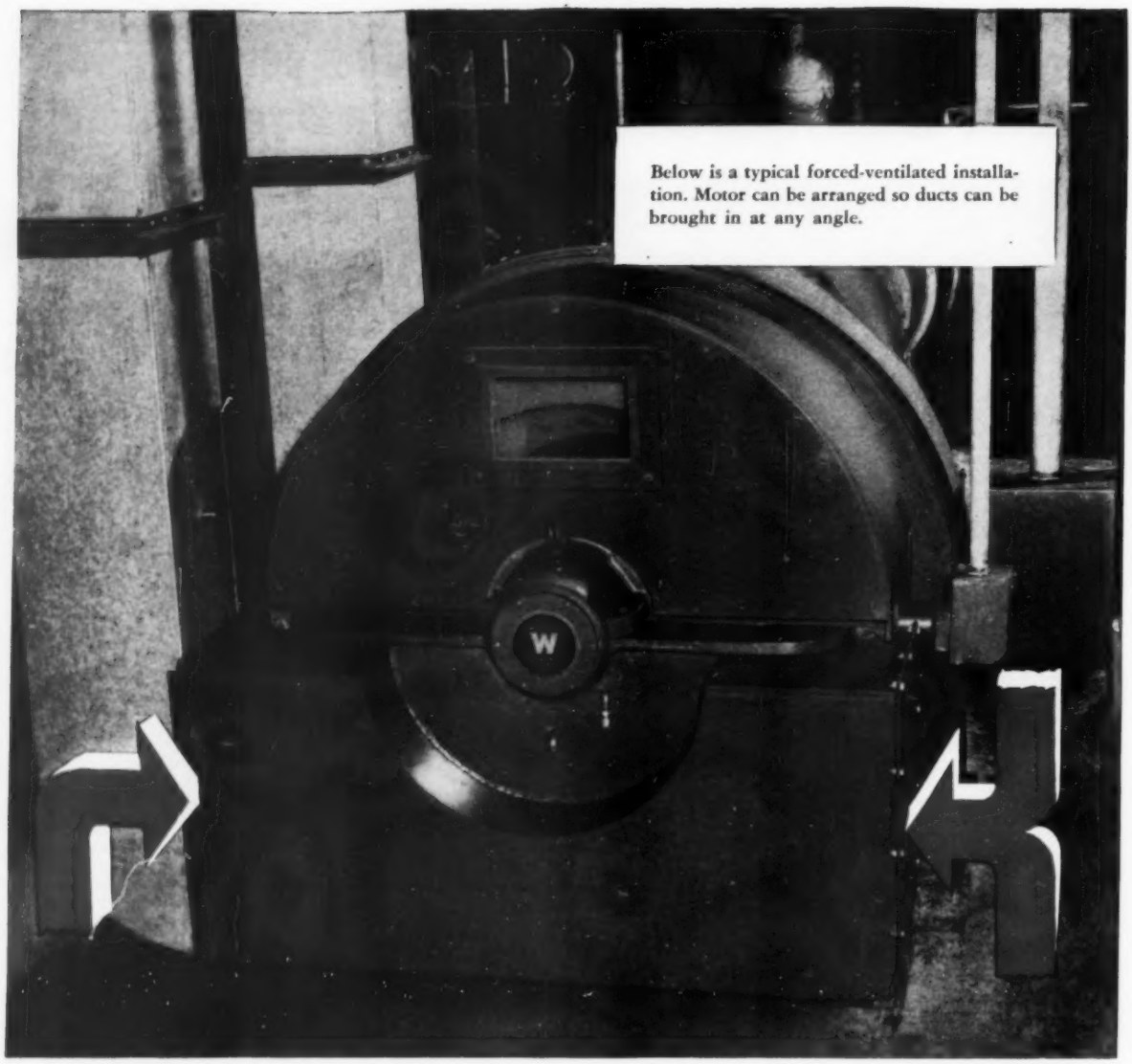
In addition to these substantial savings, the installation provided for economical future plant expansion. At present, boiler operation is rotated so all three periodically receive the same service and maintenance.

Cleaver-Brooks boilers are showing similar savings in many other businesses. Investigate — write for Catalog AD-100 and complete information on standard size oil, gas, combination oil/gas fired Cleaver-Brooks boilers, 15 to 500 hp., 15 to 250 psi.

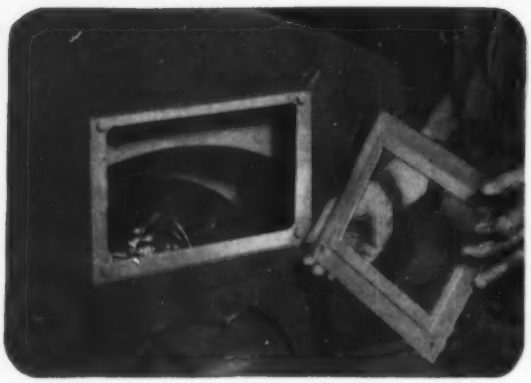
CLEAVER-BROOKS COMPANY
Dept. D-311 E. Keefe Ave.,
Milwaukee 12, Wis., U.S.A.

Cleaver-Brooks
ORIGINATORS OF
THE SELF-CONTAINED BOILER
Steam Boilers • Oil and Bitumin Tank
Car Heaters • Distillation Equipment
Oil and Gas Fired Conversion Burners

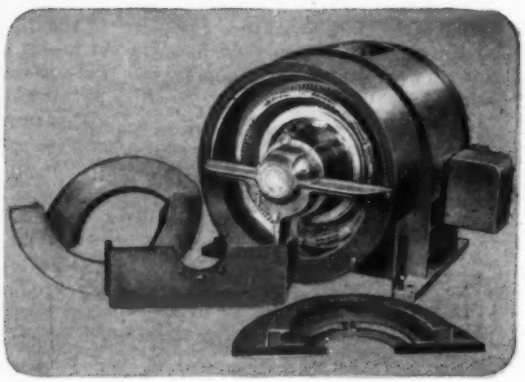
For more data circle 533 on Post Card



Below is a typical forced-ventilated installation. Motor can be arranged so ducts can be brought in at any angle.



Lucite window makes brush inspection easy. Simply remove window for quick entrance to brushes . . . for checking and inspection and maintenance.



Light, sturdy end covers and air shields are easily and quickly removed for inspection and cleaning. No crane is required. One man can do the job easily.

MORE POWER PER DOLLAR

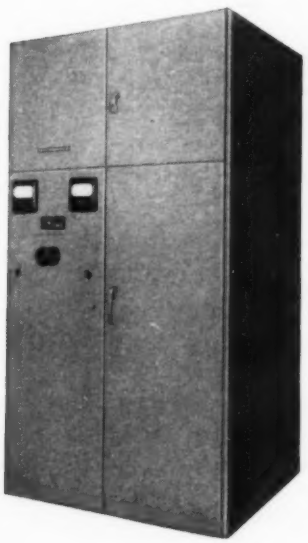
Synchronous Motor Offers New Installation Flexibility

When forced ventilation is required you can eliminate many installation problems with this synchronous motor. Air is supplied to the motor from both ends through air inlet brackets . . . two at each end, on either side. Duct or pipe connections can be brought from above . . . from below . . . from one side or the other . . . or a combination. Thus, you can position the motor without regard for duct work.

Covers and air shields, too, add to installation flexibility. They can be easily removed — by hand — for inspection or cleaning of the motor. No crane is required. Thus motors can be mounted in hard-to-reach places.

This added installation flexibility may open up new opportunities to save money with synchronous motors. In many cases, these motors will improve your power factor and reduce your power bill. They provide more power per dollar for many types of drives than any other motor.

Get all the facts on Westinghouse Synchronous Motor savings. Ask your Westinghouse representative for information on the simplified inspection and servicing these motors offer. Complete information is available. Ask him for a copy of DB-3200 or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-10354-A



YOU CAN BE SURE...IF IT'S Westinghouse

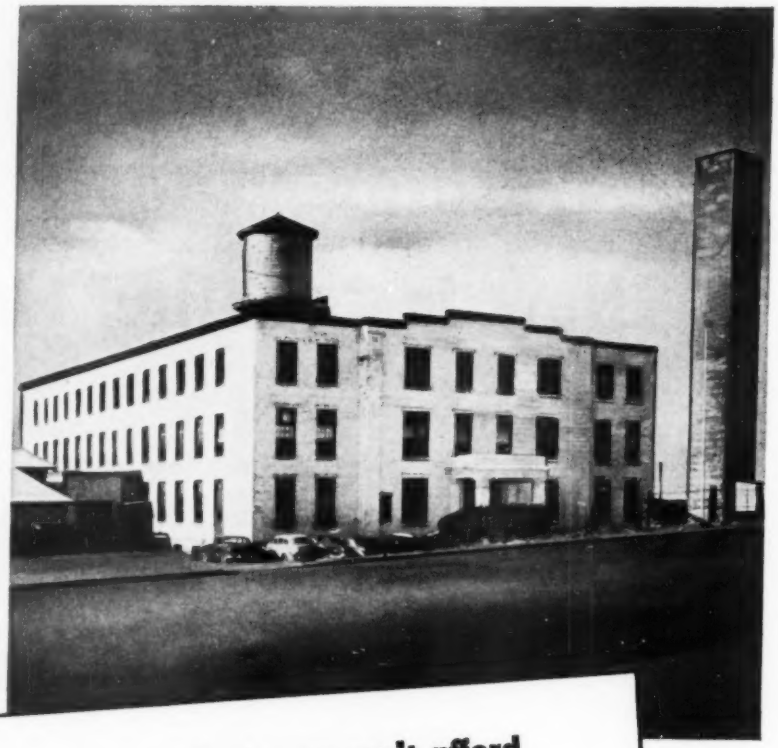
Matched control for the motor. This Slipsyn Synchronous Motor Control protects your motor investment . . . helps you get more for your power dollar.

For more data circle 534 on Post Card

"WE GET BIG SAVINGS THE MODERN WAY!

MODERN COAL-BURNING AND HANDLING EQUIPMENT SAVES THIS PLANT MORE THAN 35% ON LABOR ALONE!

This view shows The Welch Grape Juice Company's plant at Westfield, New York. The power plant consumes an average of 700 tons of coal per month. Modernization consisted of installing new stokers, boilers, controls and coal-handling equipment. This highly efficient equipment not only cuts labor costs, but also saves 18% on fuel. The complete installation will pay for itself in about 6 years.



If you operate a steam plant, you can't afford to ignore these facts!

COAL in most places is today's lowest-cost fuel.

COAL resources in America are adequate for all needs — *for hundreds of years to come.*

COAL production in the U.S.A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

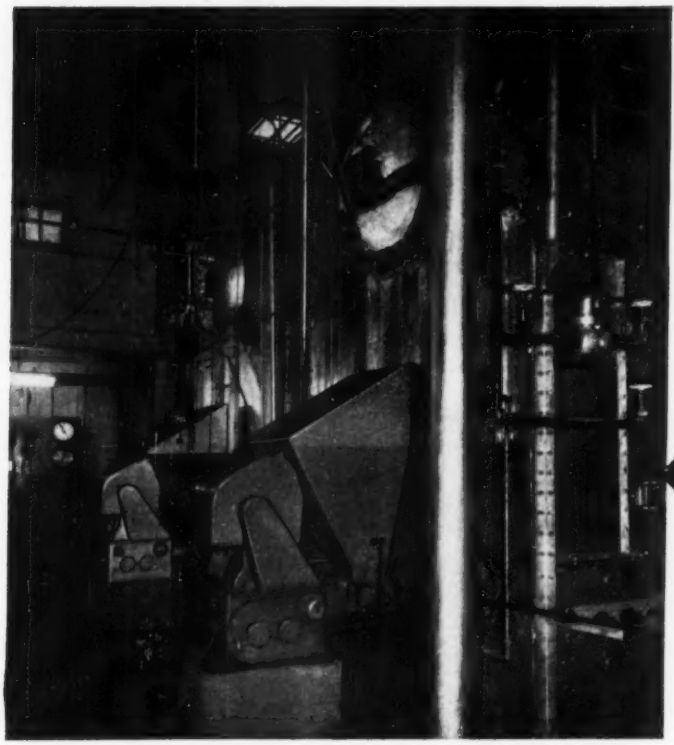
COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more — for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

FOR HIGH EFFICIENCY
FOR LOW COST

BY BURNING COAL

Other fuels would cost us far more!"



says
Mr. A. J. Monta,
Plants Engineer,
The Welch
Grape Juice
Company, Inc.,
Westfield, New York

"We analyzed the cost of coal and other fuels before modernizing our power plant. The result is this up-to-date coal installation that delivers steam at half the cost of competing fuels. That's why we say, *for economy you can't beat* bituminous *coal burned the modern way!*"

● Burning bituminous coal the modern way can save you money, too! Labor costs are cut to a minimum with up-to-date coal- and ash-handling equipment . . . modern combustion installations deliver anywhere from 10 to 40% more power from every ton of coal!

That's why, if you're planning to modernize or build a new plant, it will pay you to get the latest facts on coal. Let a consulting engineer show you how a modern coal installation designed to meet your specific needs can save you real money.

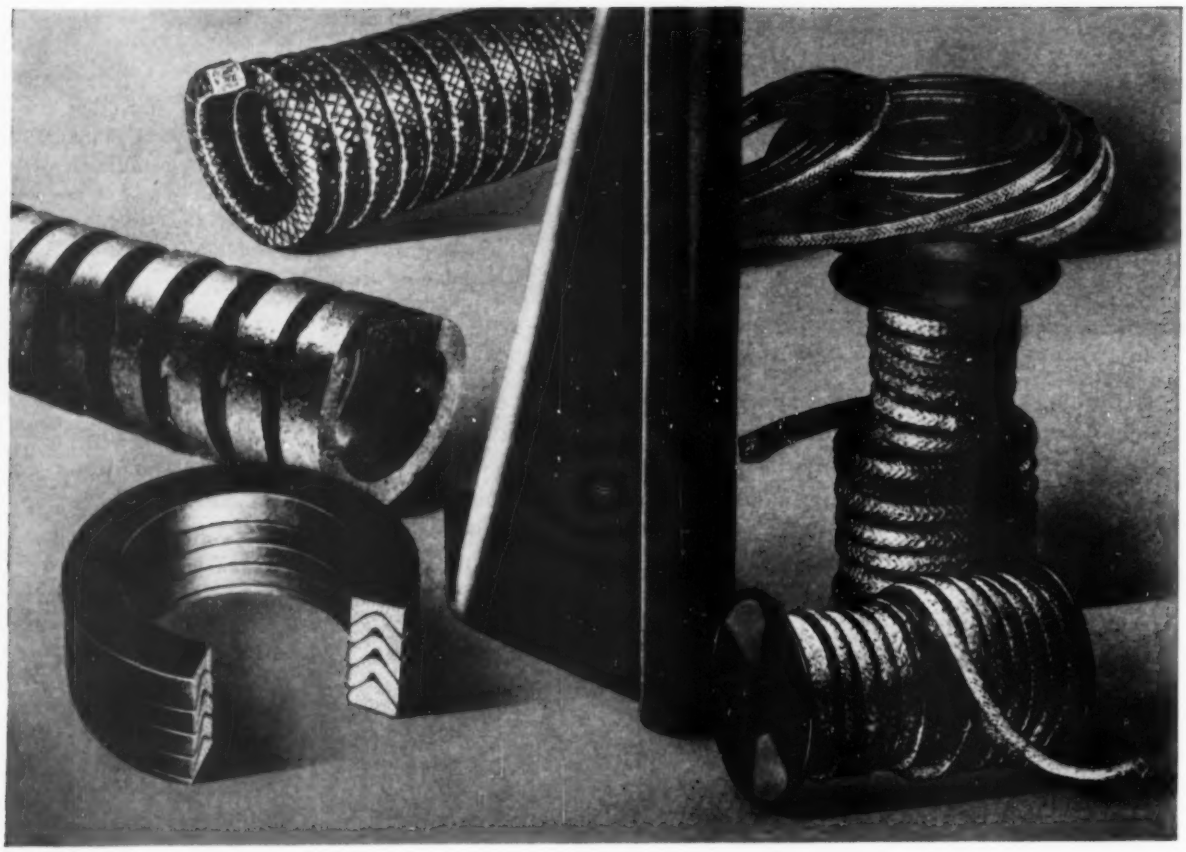
What's more, today, bituminous coal customers get a better-prepared product—designed to meet their special requirements. And coal offers future dependability no other fuel can match. Reserves are virtually inexhaustible, and America's coal industry is the world's most efficient—your assurance of dependable supply at relatively more stable prices for years to come.

BITUMINOUS COAL INSTITUTE
A Department of National Coal Association
WASHINGTON, D. C.

YOU CAN COUNT ON COAL!

For more data circle 535 on Post Card

HERE'S PACKING NEWS!



R/M's BIG 7 PACKING TYPES

95% of all packing needs are met with R/M's BIG 7

Lower inventories! Simplify ordering! Reduce downtime!

If you've thought you had to carry 10, 20, 50 different types of packings, forget it! Your plant probably needs only 3 or 4. R/M now has a basic line of *just seven* types of field-tested packings engineered to give custom-built performance in 95 percent of all applications. We call them the "Big 7" R/M Packing Types. To accomplish this engineering feat, R/M called into play 50 years of know-how and experience, and all of the research, testing and production facilities of its seven great plants. Exhaustive field testing has proved that all but the very rarest packing applications can now be met with the "Big 7" R/M Packing Types. Standardize on R/M Packings. You'll get superior performance every time. You'll lower your inventories, simplify your ordering, and reduce your downtime. For details, see your R/M distributor.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

R/M **PACKINGS**
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, MANHEIM, PA.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Teflon Products • Asbestos Textiles • Industrial Rubber Products • Abrasive and Diamond Wheels Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Sintered Metal Products • Bowling Balls

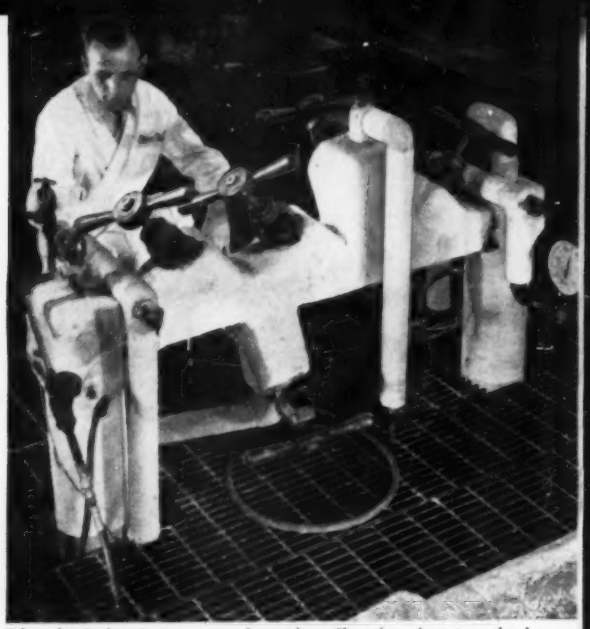
For more data circle 536 on Post Card

valve values
PHOTO NEWS

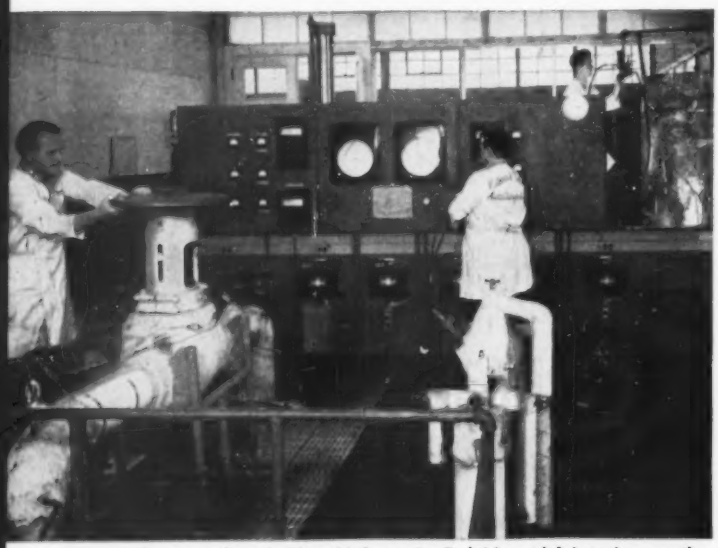
Ordeal by SUPERHEATED STEAM *Up to 1300F 5000 psi. for Edward Valves*

New superheater testing units, developed by Edward engineers and exclusive with Edward, permit a manufacturer for the first time to test valves under conditions much more severe than those they will encounter in today's actual service. These revolutionary new units permit circulating commercial quantities of superheated steam at temperatures up to 1300 F, pressures to 5000 psi. for unlimited periods of time in laboratory tests. Valves are thus subjected to the action of flowing superheated steam with temperatures and pressures far greater than they will meet in actual operation. Possible design weaknesses or operating difficulties are greatly exaggerated and thus readily corrected.

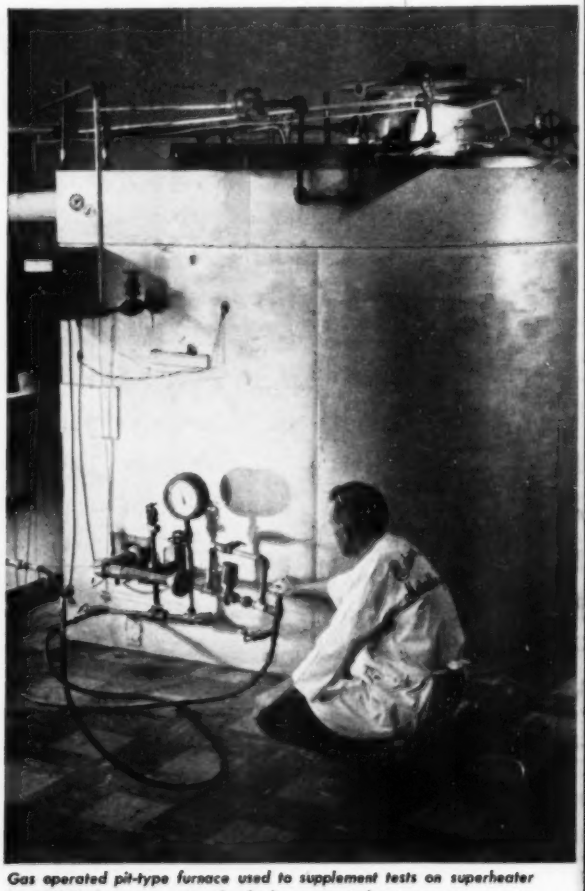
Development of this outstanding new research tool demonstrates Edward's constant search to improve its products—to more than meet the continual challenge posed by constantly increasing temperatures and pressures. For these reasons, Edward maintains the largest laboratories in the world devoted exclusively to research on steel valves. You can continue to expect the best from Edward.



Edward Univalves in test on superheater loop. Flow through center valve is alternated between superheated steam in main loop and high pressure water in and out of tee connection.



Two superheater test loops in Edward Laboratories. Technician at left is testing operation of 6 in., 2500 lb globe valve rated for 1033F, 2500 psi. which is under a thousand hour test at 3500 psi. and 1100 F with flow of 5000 lbs of steam per hour.



Gas operated pit-type furnace used to supplement tests on superheater loops. With this equipment, valve bodies are tested at temperatures up to 1500 F, pressure up to 5000 psi.

Edward Valves, Inc.

Another Product

Write for 16 page bulletin giving complete information on tests with revolutionary new superheater loop equipment.

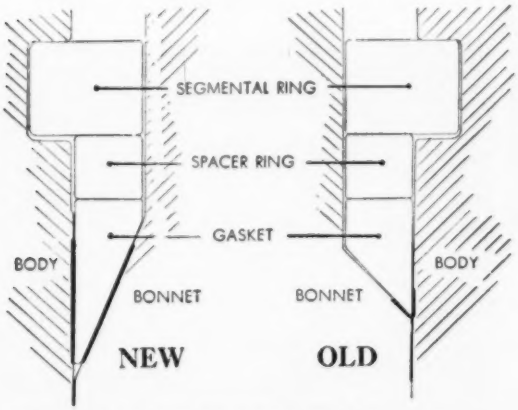
NEW IMPROVED *PRESSURE-SEAL*® DESIGN BY EDWARD

Edward, first to use pressure-sealed construction on non-return valves, has been experimenting for 8 years in an effort to improve on the original PRESSURE-SEAL design.

Final fruit of this research is the new design shown in the diagrams below. Biggest innovation in the new construction is a change in the bonnet-gasket angle from 45 degrees to 25 degrees. Other changes include a recess in the body bore above the gasket area, and a new coating applied to the gasket material.

New design advantages include:

1. THREE TIMES AS MUCH SEALING AREA. The sealing area between body and gasket is now three times greater than with the old construction. This eliminates the possibility of small leaks through minute imperfections sometimes possible with the conventional pressure-sealed construction.



2. TWICE AS MUCH SEALING PRESSURE. The new angular relationship of the bonnet and gasket gives a sealing force twice as great against the gasket for the same line load.
3. SEAL-COATING. A special coating one-thousandth of an inch in thickness is applied to the gasket. When pressure is applied to the gasket, this malleable coating is forced into tool marks and minute imperfections to give a perfect seal.
4. IMPROVED BODY SEALING SURFACE. Special preparation of the vital body-gasket sealing zone insures pressure tightness in this area.
5. EASY DISASSEMBLY. The diameter of the body bore has been enlarged just above the gasket area, facilitating disassembly and eliminating the necessity of pulling the gasket across a corroded area upon disassembly.
6. ELIMINATES GASKET DAMAGE. The cross section of the gasket has been blunted, eliminating a source of damage to the gasket during handling or storage.

Pressure-sealed construction has long been accepted as the most satisfactory for high temperature, high pressure service. These new improvements on the conventional design now available in Edward PRESSURE-SEAL Valves further establish this construction as the obvious choice for more demanding services.

EDWARD VALVES, Inc., *Subsidiary of*
ROCKWELL MANUFACTURING COMPANY
220 W. 144th STREET • EAST CHICAGO, INDIANA

GLOBE AND ANGLE STOP • FEED-LINE • BLOW-OFF • NON-RETURN CHECK • GATE • GAGE AND INSTRUMENT • RELIEF • STRAINERS

COPYRIGHT 1952, EDWARD VALVES, INC.

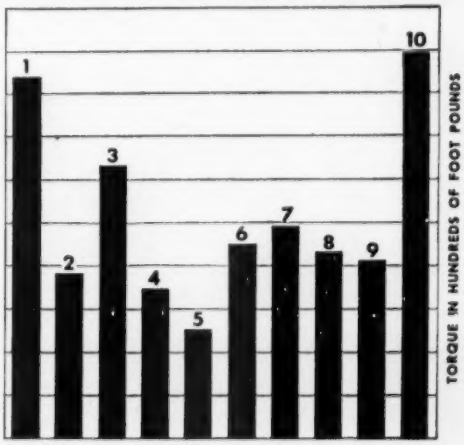
Technical Tips

High Temperature Lubricants For Valve Studs and Bushings

As temperatures increase, the problem of wear and galling between two metal surfaces also increases. Through the years a number of high temperature lubricants have been marketed to solve this problem. Most of these lubricants consist of a solid lubricant in some type of carrier which may or may not be of a lubricating nature itself.

A few years ago another new solid lubricant, molybdenum disulfide, began receiving a great amount of attention. Molybdenum disulfide has a laminar construction in which a plate of sulfur atoms is found on each side of a plate of molybdenum atoms. Molybdenum disulfide will cling tenaciously to a metal surface because of a strong metal to sulfur bond. It will slip easily against other molybdenum disulfide molecules because of the weakness of the sulfur to sulfur bond.

The chart shows the torque necessary to loosen a number of 1¼"x7" stud-nut assemblies after 5000 hours at 1000 F in a test conducted in the Edward laboratories. The stud-nut assemblies were lubricated thoroughly with various lubricants before tightening with a torque of 750 ft-lbs.



TORQUE TO LOOSEN STUD-NUT ASSEMBLY

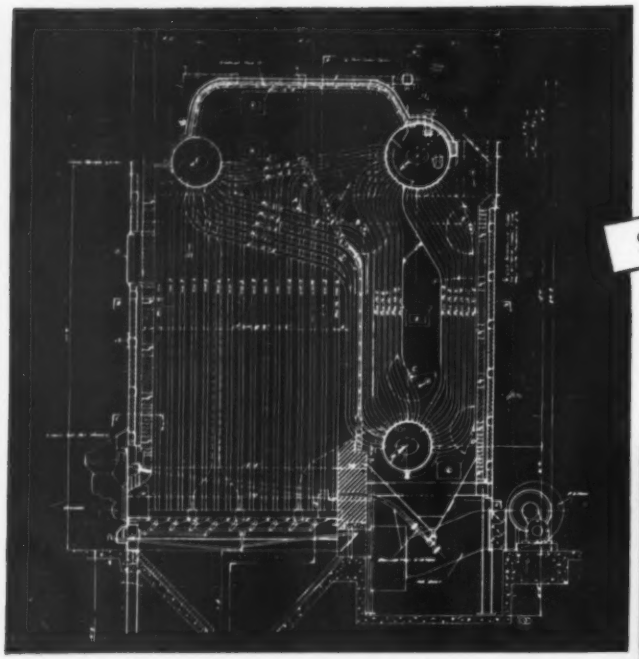
1. No Lubricant
2. Graphite Powder
3. Colloidal Lead
4. Colloidal Copper
5. Molybdenum Disulfide
6. Aluminum Powder
7. Lime-Calcium Base Grease
8. Silicone Grease
9. Colloidal Zinc
10. Colloidal Graphite

These test results show molybdenum disulfide to be a superior stud-nut lubricant. This same superiority is also true for bushing applications. It reduces the coefficient of friction to the lowest values ever obtained on a test in the Edward laboratories and substantially increases operating life.

Edward does not manufacture molybdenum disulfide lubricants. Names of suppliers will, however, be furnished on request.

Edward

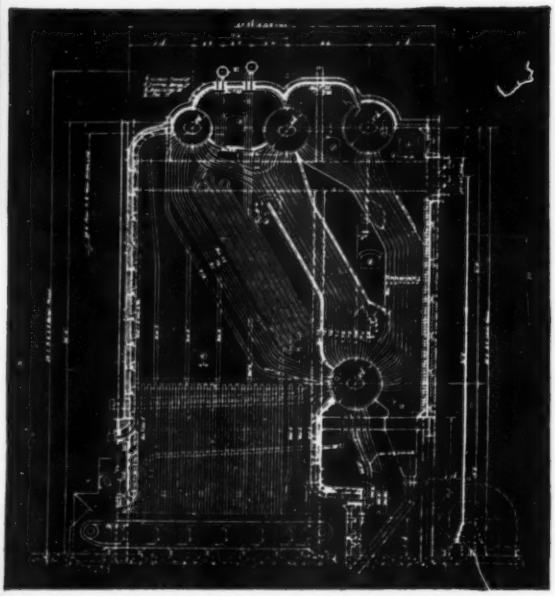
Quick Steaming at all Ratings!



Carry high overloads with high efficiency

SPECIFY **Vogt**

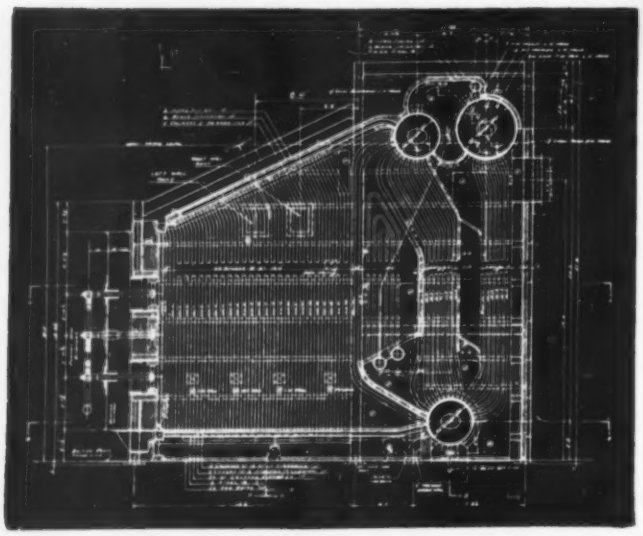
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility Mt. Carmel, Illinois, is served by this 6-,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES:
NEW YORK, PHILADELPHIA, CLEVELAND
CHICAGO, ST. LOUIS, DALLAS

For more data circle 539 on Post Card

for positive protection, pick U. S. Rainbow Packing!

In every industry you'll find this famous packing—on every piece of machinery from the smallest to the largest. U.S. Rainbow is designed for packing flanges and other parallel surfaces against hot or cold water, air, saturated steam pressures up to 150 pounds, and all hydraulic conditions. These gaskets will not blow, nor squeeze out in service. Reduce shutdown time to a minimum—with U.S. Rainbow, *the original and genuine "Red" Sheet Packing.*

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

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G-E METAL-CLAD SWITCHGEAR lineup is shown during installation in power house at Ford's Lincoln-Mercury plant, Wayne, Mich. Interrupting capacity of magne-blast breakers—totally enclosed bus compartments protect against power shutdowns.

G-E metal-clad switchgear protects power system in huge new Lincoln-Mercury plant

Secondary selective system with packaged units installed at new 35-acre auto plant

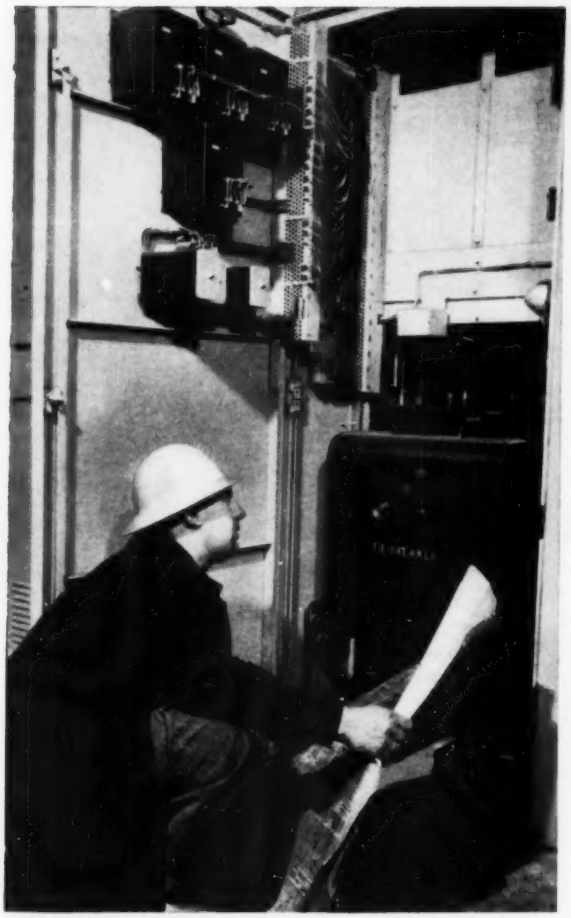
Mass production of 1953 Lincoln automobiles—rolling off assembly lines of the new Lincoln-Mercury plant at Wayne, Mich.—depends on the power distribution system behind the machines.

Ford has installed standardized G-E switchgear and nine double-ended load centers to provide safer, more reliable, *protected* power throughout the 1,500,000 square-foot plant, all under one roof.

The compact metal-clad lineup of eight feeder and two incoming line compartments in the power house takes primary voltage at 13.2-kv, purchased by Ford from Detroit-Edison. A bus tie-breaker compartment, with latest metal-clad design improvements, can isolate transformers if failure occurs—gives added reliability by feeding all units in the plant's secondary selective system.

Near switchgear line-up, two double-ended load centers, rated at 1,500-kva each, take care of power house auxiliaries. Seven 2,000-kva double-ended load centers are installed in bays in outer wall of plant building as near to loads as possible. These feed the main factory area.

G-E engineered, factory-assembled switchgear and related equipment can help you in plans for efficient, flexible, *dependable* power distribution systems. Call your local G-E Apparatus Sales Office—or write to General Electric Co., Schenectady 5, New York. 874-2



TIE-BREAKER GIVES dependable power in secondary selective system throughout Lincoln-Mercury plant. Bus tie-breaker in switchgear section contains new elevating mechanism.

PLANT ENGINEERS inspect load center unit substation in power house, shown here immediately after energizing. This is one of nine new units installed in plant.

INCOMING BUS at rear of compact, factory-engineered switchgear compartment is wired and wrapped. Rigid doors and frame of G-E metal-clad give added safety.

SMALL BAYS along outer walls of 35-acre plant each contain double-ended load-center substations, place them near assembly-line operations on main plant floor.

POWER FEEDS factory area through double-ended 2,000-kva load centers. Transformer's high side is being connected here with cable from pothead to oil switch on platform.

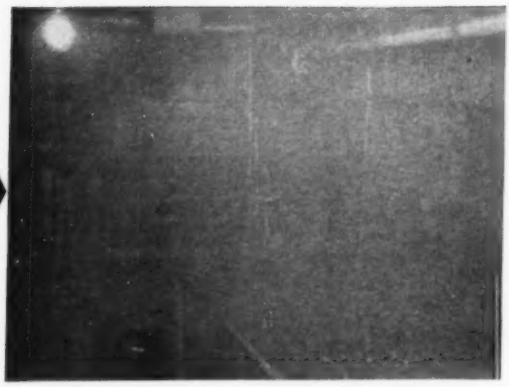
GENERAL ELECTRIC

For more data circle 542 on Post Card

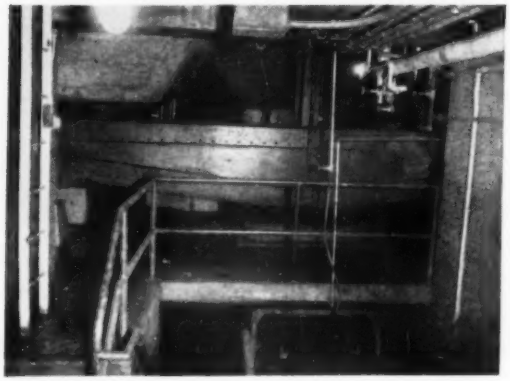
STOP COAL DUST

for 1/10 Usual Cost

at car dumpers, hoppers, crushers, belt galleries, and coal piles



BEFORE — Reciprocating feeder and belt housing in operation at large Illinois utility with Johnson-March System turned off.



AFTER — The same operation taken with the Johnson-March System turned on. Note complete absence of dust. Name of utility will be gladly furnished upon request.

● The Johnson-March Dust Control System *stops dust before it becomes airborne!* And it does it *without expensive ducts, fans and other cumbersome equipment!*

Hundreds of J-M installations daily stop dust efficiently and economically at such sources as car dumpers, hoppers, crushers, belt galleries and coal piles.

Cost of this positive dust control system averages less than 1/10 the cost of other methods. Maintenance costs are next to nothing. Installation is fast, simple and inexpensive. There is no interference with normal plant operations.

Our engineers will be glad to discuss this positive, low-cost system at no obligation. Write today for detailed information.

Johnson March

Specialists in Dust Control

Dept. PE-5 1724 CHESTNUT ST. Philadelphia 3, Pa.

For more data circle 543 on Post Card

B&W BULLETIN 6-F

Properties of Carbon, Alloy and Stainless Steel Tubing for High-Temperature and High-Pressure Service

The Story of the Croloys

New data contained in the seventh, revised edition of B&W's Technical Bulletin 6-F make it must reading for technical personnel concerned with the properties of tubing for high-temperature and high-pressure service. TB-6F contains up-to-the-minute information on:

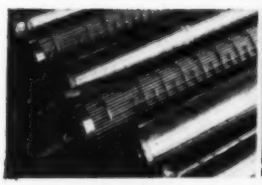
- Requirements of Tubing for High-Temperature Service
- Influence of Alloying Elements
- Chemical Composition
- Room-Temperature Properties
- Short-Time Tensile Properties
- Stress-Rupture
- Creep
- Thermal Expansion
- Thermal Conductivity
- Impact Properties
- Microstructure—Transformation Temperatures
- Air-Hardening Properties
- Effect of Hydrogen
- Common Causes of Tube Failures
- Upset, Formed and Machined Tube-Ends

On such grades as

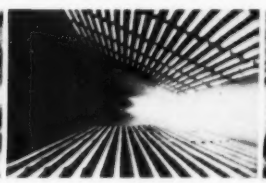
B&W	NOMINAL ALLOY CONTENT	MAXIMUM SERVICE TEMPERATURE
Carbon Steel (Killed)		
Carbon-Moly	0.50% Mo	1050F
Croloy ½	0.60% Cr 0.50% Mo	1075F
Croloy 1	1% Cr ½% Mo	1150F
Croloy 1¼	1.25% Cr 0.50% Mo	1100F
Croloy 2	2% Cr 0.50% Mo	1150F
Croloy 2¼	2.25% Cr 1.00% Mo	1175F
Croloy 3-M	3% Cr 0.90% Mo	1175F

B&W	NOMINAL ALLOY CONTENT	MAXIMUM SERVICE TEMPERATURE
Croloy 5	5% Cr 0.50% Mo	1200F
Croloy 5-Si	5% Cr 0.50% Mo 1.50% Si	1300F
Croloy 7	7% Cr 0.50% Mo	1250F
Croloy 9-M	9% Cr 1% Mo	1300F
Croloy 16-13-3	16% Cr 13% Ni 3% Mo	1600F
Croloy 18-8	18% Cr 8% Ni	1600F
Croloy 25-20	25% Cr 20% Ni	2100F

Write for your copy
—on company letterhead, please.



Chemical



Oil

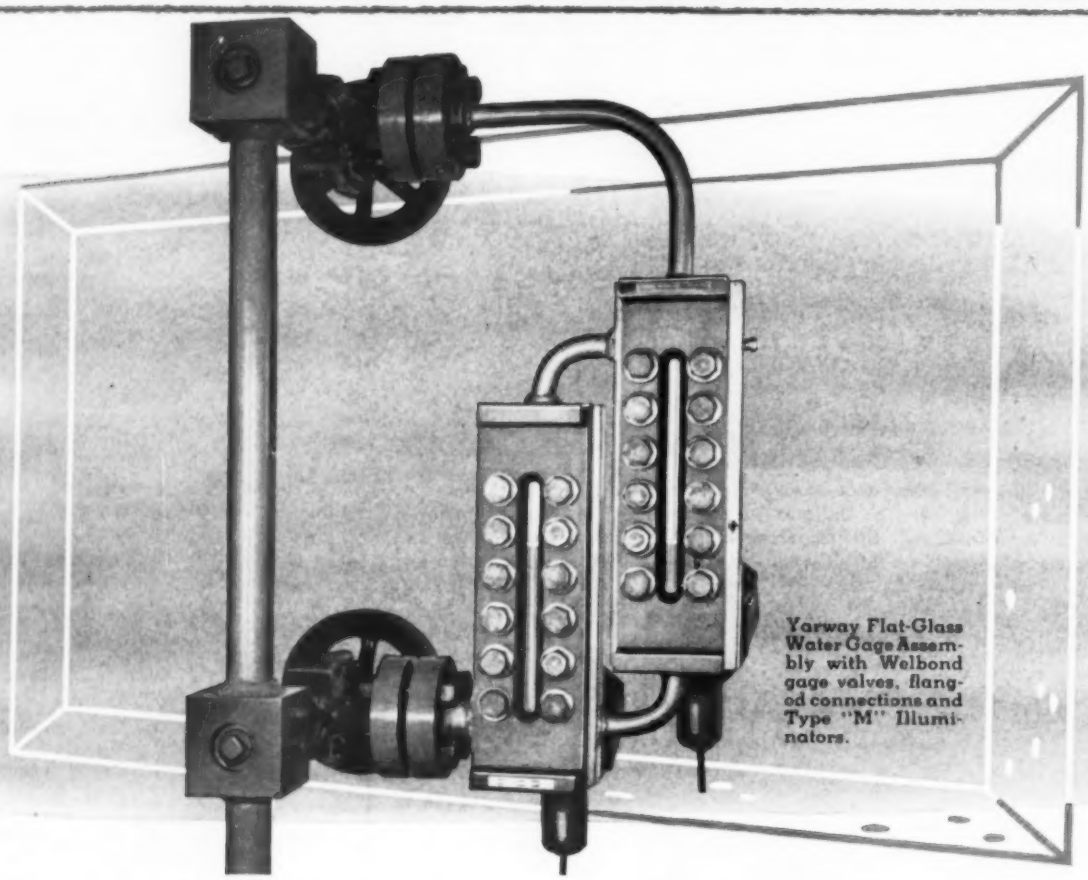
Power

TA-1739 (P)

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

What's New

IN BOILER WATER LEVEL INDICATION?



Yarway Flat-Glass Water Gage Assembly with Welbond gage valves, flanged connections and Type "M" Illuminators.

NEW *SEPARATED-DESIGN* WATER GAGES

This new Yarway water gage assembly has been developed to meet the demands for greater dependability, longer life, and more accurate readings in high pressure service.

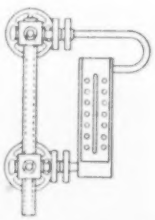
The gage glass inserts are of the Yarway pressure-sealed "floating assembly type". Yarway Welbond gage valves are used. Greater flexibility is gained by using two independent inserts, and by interconnecting expansion loops (see above).

The short connection to the drum assures greater accuracy of the gage reading, and the lower flanged connection eliminates a stuffing box. The upper flanged loop connection between the insert and gage valve allows expansion and contraction of the various components.

The tie bar-type water column linking the gage valves provides circulation to keep gage nearer drum temperature.

Yarway Type "M" Illuminators on the gage inserts cause the meniscus at water level to "shine like a star". This illuminator is especially effective in penetrating deposits on gage glass, dust particles in air and extraneous light.

For full information, write for Yarway Bulletin WG-1811.



Yarway Single Insert type gage for medium range of visibilities.

YARNALL-WARING COMPANY • 114 Mermaid Lane, Phila. 18, Pa.

YARWAY **STEAM PLANT EQUIPMENT**

For more data circle 545 on Post Card

Here and There
With The Editors

AT THE ACME STATION of the Toledo Edison Company, we met Glenn Sampson, Chief Construction Engineer for the Company, and D. J. Roux, Assistant Plant Superintendent, and Mr. Roux showed us around the station. Here, they have the world's longest 1000 F steam lines, as shown in the photograph. There is a very good reason for these long lines: if they had tried to locate the boiler and the turbine close together, the foundation conditions were so unsatisfactory that it would have cost them more to build the units close together than it did to separate them as they are now and run the steam and reheat lines between them, a total distance of 650 ft.

Incidentally, the piping is insulated so well that there is only a 10.5 degree drop in temperature between boiler and turbine. The insulation consists of two layers of 2½ inch Kaylo heat insulation applied in tri-segmental units and covered with an 0.020 inch aluminum jacket, as shown. You will observe in the picture that there are two steam lines; one being the main steam line from boiler to high pressure end of turbine, the other being the high temperature line back from the reheater to the turbine.

At Toledo, just now, they are burning gas from a local steel company's blast furnaces, most of it being used to thaw coal cars in a thawing shed, and some being used in gas torches in the main boiler furnaces.

However, the principal interest at Acme station these days is in the new Plant X being planned by the company. This will be on Maumee Bay several miles North of Toledo.

The first unit in Plant X, which at present has no other name, will be a Westinghouse 135,000 kw unit designed for 1800 psi, 1050 F, steam temperature with reheat to 1000 F. This will be the largest single generating unit in the Toledo system and will be of the unit or one boiler per turbine design. Design work is now well along and it is expected that construction will start soon.

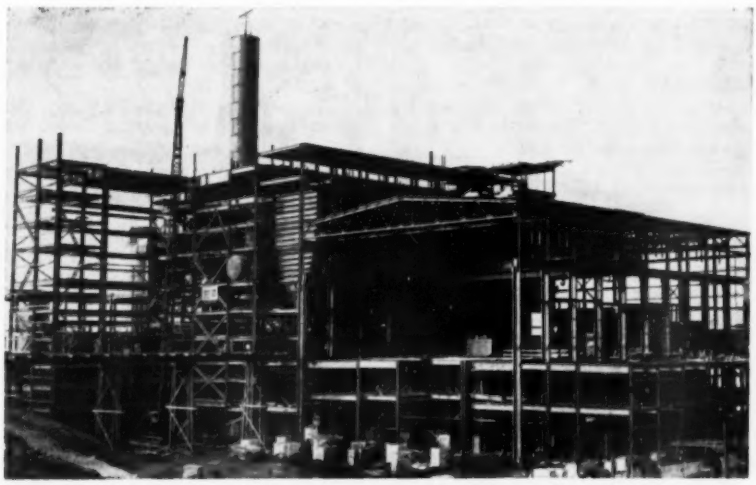
★ ★ ★

AT THE PLANT MAINTENANCE Conference in Cleveland in January, one interesting session covered Power Plant Maintenance. In that session, there was considerable discussion by the principal speaker, Charles L. Fishkin, power engineer for Monsanto Chemical Co., at Springfield, Mass., and from the floor, of the right size and organization of a maintenance crew for a power plant. How much of it should be done by the operating crew, how much by a general plant crew or a traveling crew.

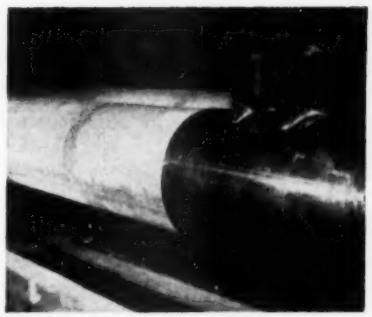
One utility engineer described the 156-man maintenance crew of his company, with a freight car full of tools and maintenance gear that can be hauled to the various power plants of the company. He went into much detail about labor problems, providing gloves and coveralls, premium pay for unusual dirty work and so on.

When he got through, another engineer got up and said his little industrial boiler plant was so small he needed only one maintenance man. But he then went on to explain how every single problem of the 156-man maintenance crew was duplicated by the problems he had with his one-man crew.

The audience laughed in sympathy, but they certainly got the point that here were some fundamental principles common to all power operations.



New Eastlake Station of Cleveland Electric Illuminating Co., now under construction



Portions of two 650-ft main steam and reheat lines, Acme Station, Toledo Edison Co.

★ ★ ★

At the Lake Road Generating Station of the City of Cleveland, Leonard Freund is Superintendent and he showed us the new construction going on there. We saw the two new Brown-Boveri turbine generators that are fast nearing completion. As they stand now, with the turbine generator casings installed but not painted and insulated, they look a little bit different from American designs.

★ ★ ★

The designers of one of the new stations do not believe in freight elevators. They are used only infrequently in proportion to their cost, they take up valuable space, and they just are not worth their salt — so they say. Instead of that, the engineers prefer to have one or more high-speed passenger elevators, which can be used by control operators or any other personnel to get up and down in the station fast when and as needed to inspect or adjust equipment. Now, how do they handle heavy pieces?

Well, the solution at that station is to open a large square hole at each working level, cover it with a grating, and then suspend a suitable hoist over the hole at the top of the station. More about this in a later article.

★ ★ ★

Recently, at the Lake Shore Generating Station of Cleveland Electric Illuminating Company, we were shown around by L. Hacker, Superintendent of the Station, and D. Ruggie, Assistant Superintendent. The station has been completely rebuilt since the original plant was constructed back in the '20s. Incidentally, they now have in the station the very latest unit on the Cleveland system, an 80,000-kw (nominal) unit and right alongside it, the first turbine generator unit on the Cleveland system, complete with reciprocating circulating pumps, reciprocating vacuum pump, separate exciters, and all the original equipment.

However, the latest unit at Lake Shore will not be the latest too long, because now the company is building the Eastlake Station, a recent view of which is shown on this page as it appeared in the early part of this year.

This new station will have two initial units of 125,000 kw capacity each to go into service this year, another similar one to go into service in 1954 but the fourth unit will be a 208,000 kw unit to go into service in 1955.

Wood waste burning power plants in some industries can be a unique asset. In this furniture plant, for example, waste recovery by steam and power generation offered economic savings likened to those possible to utility power station built at coal mine mouth

Wood Waste Makes Low Cost Power

By **DENARD L. GUSLER**
Consulting Engineer

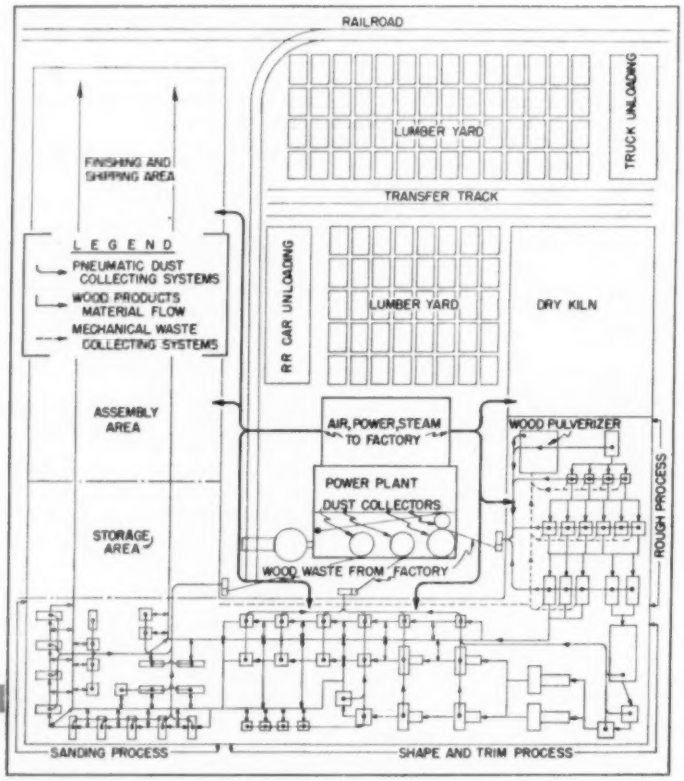


Fig. 1. Power plant of this U-shaped hypothetical furniture factory is located at the load center and the fuel center

A FEW YEARS AGO it was my privilege to write an article [1], A Post-War Power Plant For Furniture Factories, in which a practical boiler installation was suggested using wood waste as fuel, automatic combustion control, induced draft, and a turbine generator for making electric power. That article was written because of the need for improvement in the deplorable condition of woodworking plants in the South. Not long ago several plants were actually constructed and put into operation, as described in a paper recently presented before the ASME in Atlanta, Georgia. These plants are outstanding examples of wood waste recovery by steam and power generation.

Wood is costly. There are 96 trucks of lumber in the yards of the hypothetical furniture factory shown in Fig. 1. Each truck is approximately 16-ft long, 8-ft wide and 11-ft high, and represents a solid block of lumber with the exception of separations for air circulation. The yards could hold more than 1,000,000 fbm (feet board measure or board feet) worth from $75,000 to $100,000, depending upon type and grades of lumber.

[1] Page 88, POWER ENGINEERING, January, 1944.

The plant in Fig. 1 is intended to process 40,000 fbm per 8-hr day. It is typical in quantity of machinery, and in wood waste in the form of productive fbm of lumber which may amount to 65 per cent of kiln-dried wood. As it leaves the kiln, wood will weigh about 3 lb per fbm. Average waste at 65 per cent, therefore, may amount to 78,000 lb in 8 hr. On the basis of 250 working days in a year, this may reach the alarming total of 19,700,000 lb in a single year. A pound of wood as described contains about 8500 Btu. Yearly wood waste would then represent 11,900,000 lb of coal, or 5950 tons, which at $9 per ton represents $53,650 worth of fuel.

Power From Wood Waste

In other terms — fbm — this amount of wood waste per year could cost as much as $500,000 at the raw cost of lumber as it is moved into the yard. When we consider that the hypothetical plant discussed is but one of many hundreds, the waste assumes astounding proportions.

Recovery potential of wood waste has justified complete power-house installations and more than warrants expenditures of rather sizeable sums. In fact, all suggested forms of recovery are being considered at the present time and some progress is being made. One interesting possibility is to pulverize wood waste and combine it with a suitable glue. This mixture is then compressed into boards and returned to the plant process. Increased production of wood products by installation of high-cycle woodworking equipment has added further economic significance to recovery potential by increasing the amount of waste.

The problem of recovery for power generation can be generally resolved into basic components as follows:

(1) Collection and transport system to carry waste from each individual woodworking machine to a storage facility.

(2) Wood waste storage bin and related equipment.

(3) Boiler and related equipment for conversion into steam.

(4) Generator and related equipment for conversion into power.

These components are shown to some extent in Fig. 1. A furniture plant is unique in that, with only a few exceptions, there is no other industry wherein the power plant can be so completely integrated into plant design. In most industries where the

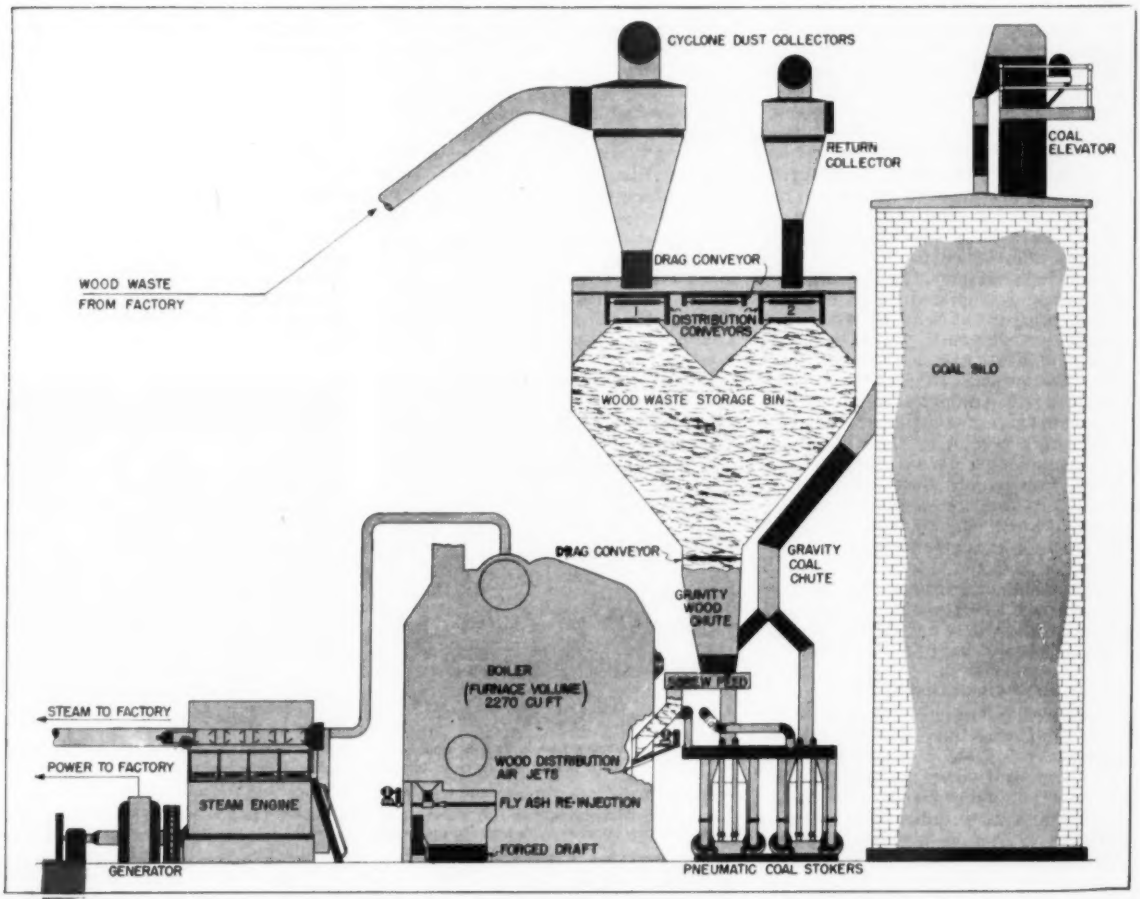


Fig. 2. In this actual installation sawdust, chips and shavings are collected in a storage bin from which they are fed to wood waste burning boilers to supply process steam and generate power for the factory. Satisfactory operation and substantial savings have been accomplished

power plant furnishes services only, its physical relation to the factory depends to a great extent on the practical problem of supplying the power plant with fuel. For this reason the ideal furniture plant can be constructed in the shape of a U with the power house in the center. This arrangement greatly shortens the length of necessary mill exhauster lines and effects a corresponding saving in first cost, maintenance and horsepower. In like manner, electrical and steam distribution lines are affected.

In other words, it is possible in a properly designed furniture factory to locate the power plant at the load center *and* at the fuel supply center. A similar situation would exist in a public utility power plant if it were located in a power distribution center and at the same time located at the mouth of a coal mine, or oil well. This condition seldom exists, but when it does full advantage should be taken of it.

It will be noted that the factory in Fig. 1 conveniently divides itself into four major sources of waste products. They are:

(1) Rough process; sawdust, blocks and sticks.

(2) Shape and trim process; sawdust, sander dust, blocks, sticks and veneer scrap.

(3) Sanding process; sander dust.

(4) Wood pulverizer; all waste material not handled by pneumatic systems.

Sources of Wood Waste

Manufacturing commences as lumber comes to the plant by rail and truck. Lumber is stored in a yard for further air-drying, and then moved into the dry kiln. From the dry kiln it is moved into the rough process and the transition into a usable product begins. As the lumber travels through planers, cut-off saws, rip-saws and moulders that comprise the rough process, it surrenders sawdust to the pneumatic exhaust system. At the same time it is being trimmed, whole grained and sized. This results in considerable waste in the form of scrap and blocks that must be carried to the pulverizer and ground into combustible chips which are then pneumatically conveyed to the storage bin.

The shape and trim process is the area where wood is further sized and shaped into individual pieces that comprise a piece of furniture. It is here that wood is glued into panels. Waste is largely sawdust and shavings which are picked up by the pneumatic system. However, there is still considerable bulk scrap to be transported to the pulverizer.

Third source of waste is sander dust, collected in the sanding process area. This dust is almost microscopic in size and is surrendered almost entirely to the pneumatic system. Fineness of the dust makes it explosive in nature and dangerous to handle. It can be burned in furnaces like pulverized coal. Since it generally enters the furnace in batches or clumps that quickly ignite and explode, it presents a problem and hazard not readily overcome.

Miscellaneous waste is transported mechanically by means of drag or rubber belt conveyors to the pulverizer. Degree of fineness of the pulverized product will depend on the mesh of the screen through which waste passes as it leaves the pulverizer. Hogged refuse is a wonderful fuel and gives the furnace a degree of combustion stability not otherwise possible.

It is possible in the carefully engineered plant for services to the factory to be exactly balanced by waste fuel that is supplied to the power

plant. Thus, the furniture factory can become almost completely self-sustaining. Whether or not this condition is desirable will, of course, depend on the plant under consideration.

Collection Systems

It is standard practice for the collection and transport system to be pneumatic. For the plant shown in Fig. 1, a system handling approximately 200,000 cu ft of air per min would be necessary. This volume of air would be handled at an average static pressure of 8 in. of water and result in exhauster power requirements of about 450 shaft hp at 60 per cent fan static efficiency. Hogged wood waste would be handled by a separate extra-heavy fan with a somewhat higher velocity than the regular system. A velocity of more than 4000 fpm would be necessary in mains, and branch connections would require a velocity of 4500 fpm. Mill exhausters in this instance are located outside of the factory. This is a practical installation, saving valuable floor space. Dust collectors are located over the wood-waste storage bin.

An Actual Installation

Figure 2 is a diagram of an installation that was developed and is in operation for wood waste recovery by steam and power generation. The installation is shown free of surrounding structures to indicate its extreme flexibility. Storage bin, coal silo and engine may be placed at any point around the boiler and at varying elevations to suit a particular installation.

The storage bin was designed primarily for storage and feeding of sawdust, chips and shavings to wood waste burning boilers. It was designed to be readily extended and adapted to feeding of waste to more than one boiler.

There are two distribution conveyors in the top of the bin. One conveyor operates under the incoming collectors to level and distribute waste throughout the entire length of the storage bin on that side. The other conveyor operates under the single return conveyor to perform the same function on the opposite side. It is thus possible to put fuel into the bin at different points along its length and fill it completely. Distribution conveyors are independently driven through reduction gearing at a constant speed. Drive machinery may be located inside or outside the bin.

Fuel accumulated in the storage bin is fed directly into gravity feed chutes by a drag conveyor that travels the length of the bottom of the bin and returns through the top of the bin. There may be one or more chutes per boiler, as shown in Fig. 5. Drag conveyor is operated by a variable speed drive at a speed in excess of that required to keep the chutes full of fuel at any given firing rate on the furnaces. Keeping the chutes full prevents communication between furnace and bin and minimizes danger of fire. Excess fuel dumps into a fan at the end of the drag conveyor and is fed pneumatically to the return collector. This results in an outstanding feature — fuel in the bin is constantly in motion regardless of the firing rate. This constant agitation results in a comparatively uniform density of fuel throughout the bin and does away with a tendency to pack and arch, often a downfall of storage bin design.

The screw feed in Fig. 2 discharges by gravity directly into the furnace above a high-velocity low-volume air jet, energized by a pressure blower. These air jets are the most vital part of furnace design. They establish both necessary turbulence and area distribution otherwise not possible. They make it possible to burn satisfactorily fine sander dust and give it flame stability. Since suspension burning is encouraged, jet air volume must be balanced to provide it without impingement on furnace water walls. These jets must be automatically controlled by the master combustion control to achieve maximum combustion efficiency. Well-designed and properly-installed air jets make it possible to achieve 15 per cent CO_2

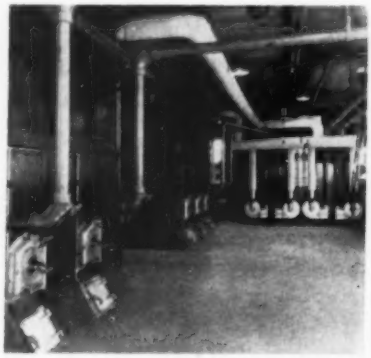


Fig. 3. Coal, standby fuel, is fed to boilers by four pneumatic coal stokers (rear). Note air jets

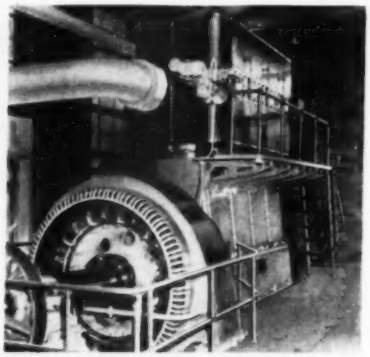


Fig. 4. One of two multi-cylinder uniflow engines; each is direct-connected to a 1250-kva generator

Fig. 5. View shows bank of gravity chutes which feed wood waste from storage bin to boilers. In the background is a gravity chute from the silo to feed coal to the four pneumatic coal stokers, if necessary

while burning wood waste for this type of installation and at the same time to have almost smokeless combustion.

Furnace has water-tube side and back walls and a radiant front wall. The radiant front wall had a tendency to lean in toward the flame and to bulge out. A completely water-wall furnace would, therefore, be better. It was thought that stable combustion would be difficult with the water-wall furnace, but such was not the case. Sawdust, shavings and sander dust all burned in suspension, while hogged waste burned almost instantaneously as it dropped onto the grates. When burning wood it was necessary to cover grates with a 2-in. layer of course gravel. Gravel made it possible to achieve uniform distribution of forced-draft air and was cheaper than burning coal to obtain cinder to cover the grate.

The fly ash reinjection system shown in Fig. 2 functioned very satisfactorily and was of assistance in maintaining turbulence in the furnace.

Combustion Control

A furnace volume of approximately 2770 cu ft was adequate for a maximum satisfactory combustion rate of 5800 lb of wood per hr, or approximately 2 lb of fuel per cu ft of furnace volume. Beyond this point the furnace became saturated, and it was difficult to distribute forced-draft air adequately. This would appear to be a suitable criterion where a standard water-wall furnace is used and air for combustion is supplied through the grates and over the entire grate area. It is necessary for combustion to take place in the furnace prior to entering the first tube bank. Any other condition will result in serious smoking and possibilities of secondary combustion.

A completely automatic system of combustion control was used with the uptake damper independently controlled. It was set to provide a furnace draft of 0.1 to 0.12 in. of water. It was difficult, if not impossible, to operate the furnaces under a draft of 0.2 in. of water or more until the air distribution jets were automatically controlled and properly designed. This high furnace draft resulted in an unnecessarily high flue gas temperature. Other meters used in conjunction with combustion control were steam flow, flue gas temperature, and CO_2. The indicating and recording CO_2 meter is invaluable as an aid to maximum combustion efficiency.

When such a power plant is designed to furnish complete service to the factory, there are factors to be considered which sometimes make it desirable to have coal or some other fuel as a standby source. For example, there might be periods of low production where power requirements could exceed waste fuel supply. Then, it is necessary to supplement the supply of wood waste with a secondary fuel. As shown in Fig. 2, a silo storage system and pneumatic coal feed (see Fig. 4) is admirable for this purpose in some instances. Included would be a track hopper, flight feeder, bucket elevator, vitrified tile silo and a chute system to a spreader stoker. The stoker could be either pneumatic or mechanical.

Under the system illustrated, coal is unloaded from railroad cars and conveyed to the tile silo. The silo has an upper live storage compartment and a lower reserve storage compartment. Coal is reclaimed to live storage by the coal elevator and at the same time this recirculation helps to prevent spontaneous combustion. Coal feed can be cut in manually or set to cut in automatically when supply of wood waste is low. The same automatic controls necessary for the wood waste feed can be used for coal feed. It is then desirable to have a fuel-air ratio controller.

The wood waste storage bin has another excellent use to which it has not been put to my knowledge. Suppose, for example, a factory used this system and wanted to reclaim a portion of their wood waste seasonally in the form of boards, as suggested earlier. This process could be located adjacent to the power plant. A drag conveyor and chute arrangement could be designed to feed waste to the reclaiming process. It would thus function to feed wood waste for power generation or for process reclaiming, as necessary.

Power Generation

Fourth basic component to be considered is one about which there is considerable difference of opinion. A number of plants have literally thrown away their generating equipment and now buy their power. On the other hand some of the most outstanding plants in this country generate their own power and are very happy with the results.

In the design stages of the plants being discussed, consideration was given to the following power generating arrangements:

(1) Two bleeder type turbines, operating condensing, connected to two 1250-kva generators.

(2) One engine operating at 200 psi and exhausting at 10 psi to a turbine, operating condensing. With this proposed arrangement the turbine would use only exhaust steam not actually required for processing.

(3) One bleeder turbine, operating condensing, to a 2500-kva generator.

(4) Two multi-cylinder uniflow engines directly connected to two 1250-kva generators; the engines to be operated from steam at 200 psi and exhaust at 10 psi. (See Fig. 3.)

Since the plant operated on an 8-hr day with load variations from 150 to 1500 kw, the last arrangement, No. 4, was selected because the engine water rate is constant over a wide variation in load. It is also very easy to start and, of course, requires very little maintenance. If the furniture factory was operated for 24 hr a day, the turbine would probably have

(*Continued on page 127*)

Fig. 6. *Chart shows relative net gain in pounds of steam generated between old and new installations. Results are tabulated over a period of one year*

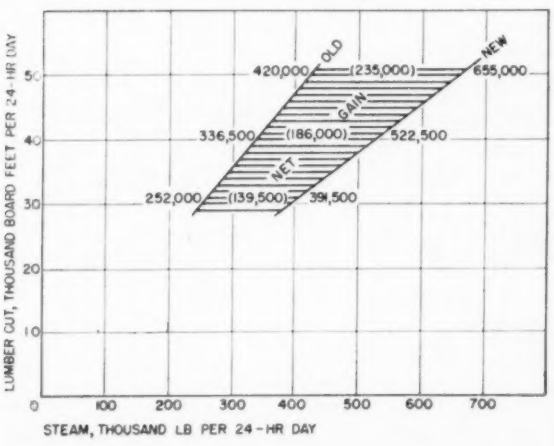


Fig. 7. *This chart shows a similar relative gain in kwh generated between old and new installations, based on 21-day month over a period of one year*

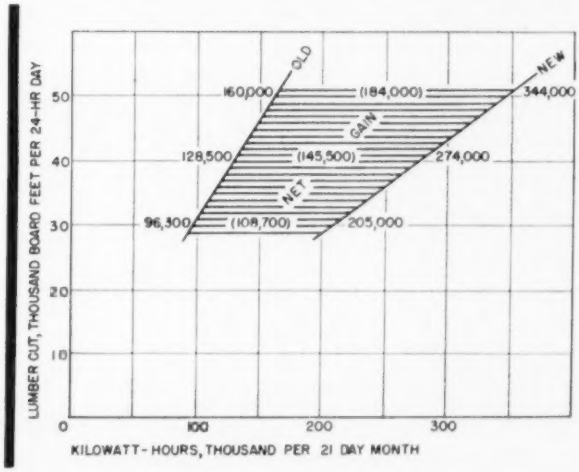


Fig. 1. General view of a recent turbine room, showing how high-bay prismatic reflectors provide good light on the turbines where needed. Note canopy lighting of turbine control panels

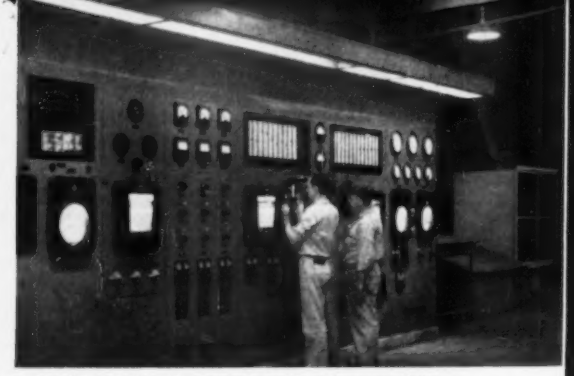


Fig. 2. Boiler and turbine control panels with canopy lighting

Fig. 3. This central control room in power station gets illumination from solid translucent luminous Plexiglas ceiling as above

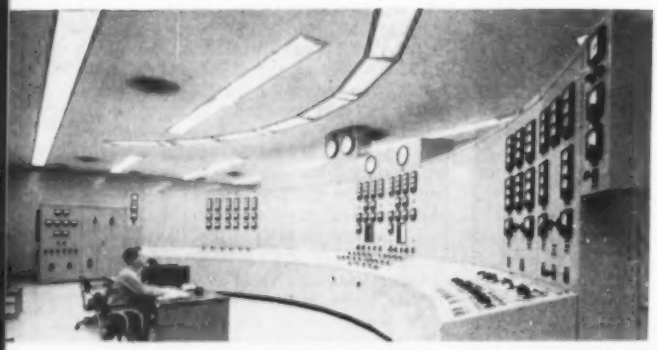


Fig. 4. Electrical control room with Holophane troffer lighting tilted 12 deg

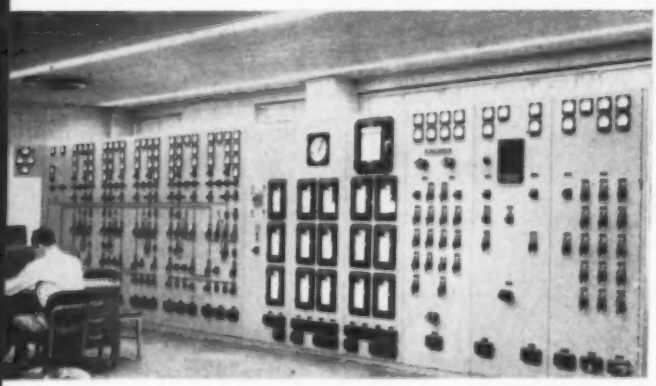


Fig. 5. Electrical control room with flush troffer lighting in strips across ceiling

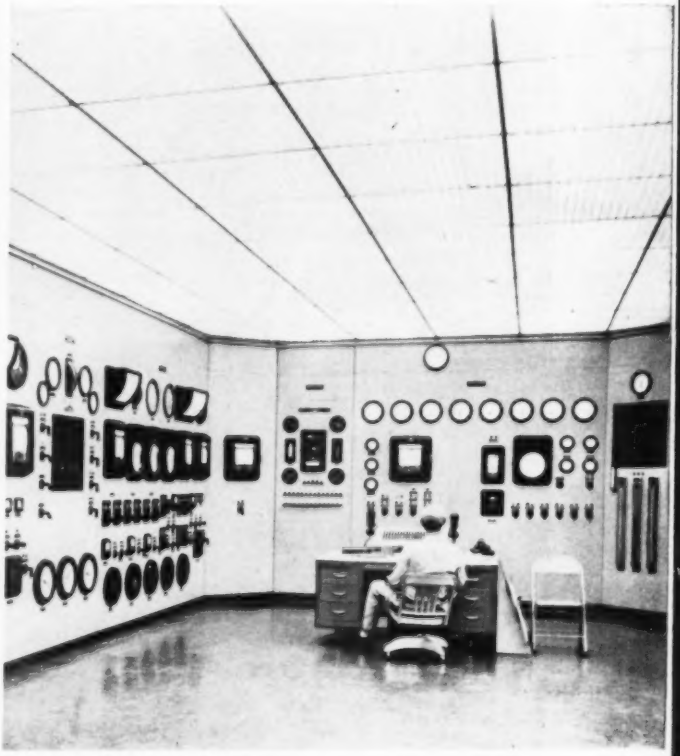


Fig. 6. Centralized boiler and turbine control room with louver-all ceiling

With increasing effectiveness, the power industry is taking its own medicine—better light, better sight—especially in its power plants, despite increases in lighting cost per square foot. The major factor has been demand by operators for better light to promote safety, ease of operation, increased comfort; they unanimously pronounce

Good Power Plant Lighting A Must—Not a Frill

ILLUMINATION needed throughout a modern power station varies widely, as shown in the table, from 50 to 100 foot-candles in control rooms to 5 foot-candles in passageways and areas where no operations are performed.

The illumination must be adequate for the areas and equipment, give minimum annual cost, and have neat appearance. Power plant fixtures should be simple and utilitarian.

Fluorescent lighting is now almost universally used for protected areas such as control rooms, offices, and laboratories.

Control room lighting is of special importance as more and more of the control for the entire station is being centralized here. Figures 3, 4, 5 and 6 show the various types of illumination used. The lighting must be the most effective that can be devised, in order not to handicap the operator in using the control devices.

In some cases, instruments have been internally illuminated. Antiglare glass has been used in instruments or the instruments tilted to eliminate glare.

Ideal control room illumination would be a uniformly lighted ceiling of low brightness with no luminaires or fixtures visible. To meet this requirement, ceilings as shown in Figs. 3 and 6 are often installed. These cost more than other types but quality of lighting for the control center is more important than cost.

Switchgear rooms may be satisfactorily lighted by a row of fluorescent or cold cathode units to light the face of the cubicles.

Turbine room is the most impressive part of a station and should have adequate but not excessive illumination. Figure 1 shows a good example. The turbine room basement, where many important pumps and auxiliaries are placed, is often difficult to light well because of the maze of piping, structural steel, galleries and stairways. Great care is needed to obtain good lighting here for equipment, control points, and the like.

Boiler rooms have many operating levels and much ingenuity is required to place lighting and still get required headroom. On outdoor installations gallery lighting is important, and weather-tight lighting fixtures and circuits are imperative. Coal handling structures, outside and inside, must be well lighted for night operation. Power plant chimneys and stacks must be lighted where airplane traffic is a factor; this must be taken up with CAA.

Lighting of miscellaneous buildings, such as intake crib, oil pump house, paint shop, maintenance building, gas valve house and the like must receive attention. Roadways, parking lots, fences, must be lighted. Outdoor switchyards may be well lighted with enclosed, inverted prismatic glass substation units.

All the foregoing types of power station lighting were discussed in great detail in a paper by S. L. Chapin of Sargent and Lundy presented in 1951 before the Midwest Power Conference and published in the Conference Proceedings, available from Illinois Institute of Technology, 3300 Federal Street, Chicago, Ill. Special thanks are due: Stone & Webster Engineering Corp. and Potomac Electric Power Co. and Holophane Co., for use of Fig. 4; Rohm & Haas Co., and Philadelphia Electric Co. for Fig. 3.

TYPICAL LIGHTING INTENSITIES FOR POWER STATION AREAS

	Foot Candles
Control Room—General	50
Control Room—Front of Panels (Vertical)	25
Switchgear Room	15
Turbine Room—Main Floor	20
Turbine Room—Basement & Cond. Pit	15
Boiler Room—Main Floor & Basement	15
Boiler Room—Galleries & Stairs	10
Gage Boards—Front of Panels (Vertical)	25
Crib House—Intake Well	10
Water Treating Plant & Pump House	15
Crusher House	10
Coal Conveyors	5
Switchyard	0.5
Offices	50
Laboratory	30
Assembly Room	25
Store & Stock Rooms	10
Machine Shop & Maintenance Shops	30
Toilets & Locker Rooms	10
Stairs, Passageways & Corridors	5

Figures shown are values after 25% depreciation.

Emergency Lighting:
For turbine and boiler room—approximately 10% of total lighting load of those areas.
For control rooms and gage boards—approximately 20% of total lighting load in these areas.

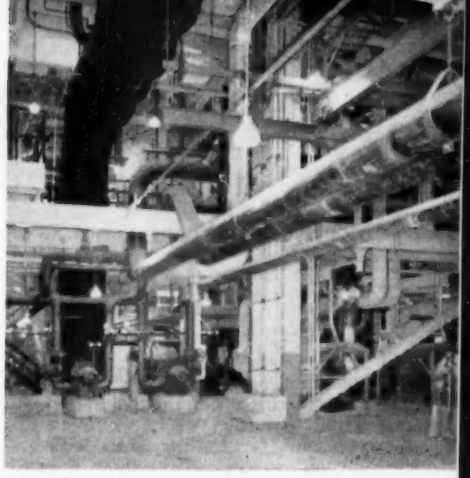


Fig. 7. Good lighting is needed for lower power plant levels where many auxiliaries are located

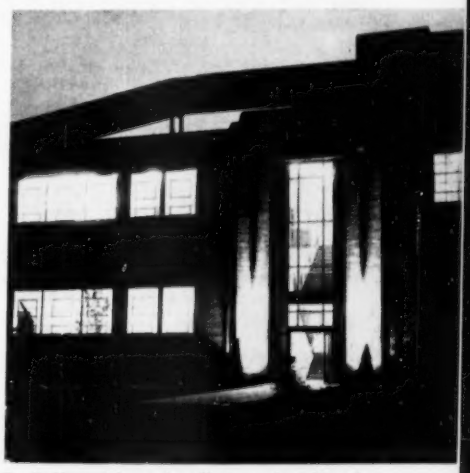


Fig. 8. Unusual decorative effects may be achieved at night by originality in lighting the building

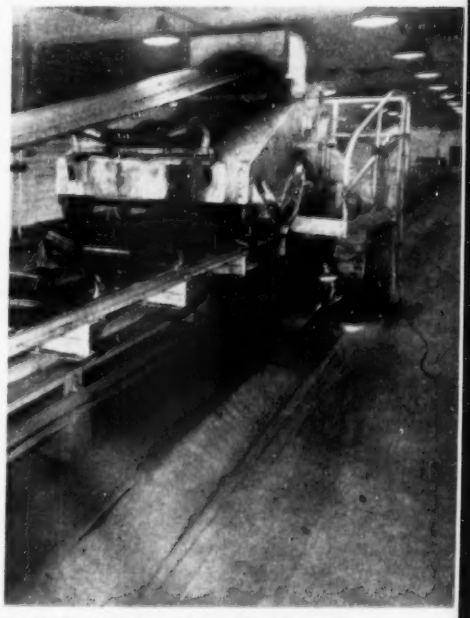


Fig. 9. Good lighting of all coal-handling equipment, both indoors and outdoors, is of great importance, for night operation is often necessary

Du Pont—

How They Lower Power Investment

Careful study and willingness to try the unusual are two ingredients du Pont has found necessary to cutting power plant investment. Here are some steps taken in 8 of their recently built steam plants

REDUCED INVESTMENT is an important measure of good engineering. In designing industrial power plants, a well-engineered job should give the lowest economical investment for the required facilities without sacrifice of quality of engineering; quality of finished product; and safety. These three items are basic and must be part of a well-engineered job.

It is also important that a mutually agreeable basis of thinking and methods of approach be developed. Below are some of the factors important to attaining the objective:

(1) Fundamental engineering thinking.

(2) Firm basic knowledge, including the process demands to be supplied by the facility.

(3) Basic data regarding costs, both estimated and actual.

(4) Knowledge of materials, equipment and apparatus available.

(5) Ability to influence the operators to accept departures from the conventional.

(6) Ability to influence manufacturers to develop competitive equipment that will best meet our needs.

In addition, to make certain that a complete unit is of uniform quality, the philosophy followed in designing and selecting the mechanical equipment should be followed with the component parts — concrete work, structural steel, civil engineering facilities, electrical components and instrumentation. It is therefore essential that central leadership for the entire facility be established and that the responsibility of that leader be recognized by all working on design of the components. In order to achieve this, the leader on such a job, in our company the senior power engineer, and others involved should keep thinking about items that can be eliminated or those that can be reduced in size and investment cost.

Analyze Investments

Industrial power plants differ from utility power plants — and even between industries. Steam, electricity, process water, compressed air and refrigeration may be exported from one plant, and power and process operations are usually closely integrated. These are important factors when trying to keep investment down in design.

Ignoring process variables, and considering power facilities in a conventional aspect, investments must be analyzed in considerable detail to lower costs. Investments in 8 power plants installed recently to supply our manufacturing facilities have been broken down by expenditures under handy subdivisions. Relative costs of each item are shown in the table as a per cent of the whole to indicate where investment dollars are going and to provide a guide for reductions.

Used as an investment reduction guide, table gives per cent of total investment for each of 7 arbitrary classifications in 8 power plants recently installed by du Pont to supply steam to manufacturing facilities

Plant—	A	B	C	D	E	F	G	H
Number of boilers	3	1	2	2	1	1	2	6
Capacity of each (thousand lb)	40.0	150.0	50.0	45.0	80.0	8.6	60.0	180.0
Fuel fired	Coal	Coal	Coal	Coal	Oil	Oil	Gas	Gas
Per cent of total investment:								
Steam generator	34	31	33	41	37	27	40	47
Fuel handling	11	7	7	14	2	8	—	—
Dust and ash handling	6	2	5	11	—	—	—	—
Feedwater	9	9	9	6	10	19	12	15
Piping and valves	18	16	14	12	24	7	16	19
Electrical (no generation)	7	8	5	6	5	2	7	7
Building	15	27	27	10	22	37	25	12

A table can be made showing actual dollars of investment per unit output. Such figures can be compared with a par or goal. Use of goals requires consideration of unusual factors such as premium cost for quick delivery, geographic features, plant size, etc. This type tabulation still offers a useful yardstick of progress, however.

Note that plants D and H have the highest steam generator cost, but lowest building cost. These plants are in the South and equipment is nearly all outdoors. Piping cost is lowest on plant F — a small, oil-burning plant without an extensive distribution system.

The foregoing factors were explained in considerable detail in two papers presented at the annual ASME meeting in New York, 1952: Economical Industrial Power Plant Design by C. S. Robinson, Assistant Principal Power Engineer; and Investment Costs — Industrial Power Plants by J. Campbell, Senior Power Engineer; both of the E. I. du Pont de Nemours and Company. The authors then brought out the ways in which these results were achieved.

Here are some steps taken to reduce investment in major items of total installed cost.

Steam Generator

(Includes boiler, furnace, fuel burning equipment, draft and dust collecting equipment, foundations, supports, drives and direct auxiliaries.) Largest item is the boiler itself. Individual boiler capacity is determined by steam load characteristics. Summer and winter peak requirements are studied so as to load all boilers during winter, and yet have one boiler at a time off the line in summer for inspection and overhaul. Equipment is selected to permit uninterrupted operation during coldest winter months. It may even pay to curtail production during unscheduled outages rather than carry added boiler investment.

Steam pressure and temperature selection precludes the possibility of future electric generation. Boilers may be designed for superheat, but superheaters are not installed until there is a definite advantage. Boiler auxiliaries are designed for plant start-up conditions unless temperature or pressure increases are definite possibilities.

Boiler and firing equipment selection is made only after consideration of all types of applicable units. At one plant where small boilers in various areas are more economical than a central power house, oil-fired package boilers are used. Small package boilers have other advantages in addition to minimum structure re-

quired. As a plant expands to larger boilers, package units can be easily removed and used elsewhere, preserving utility of investment. In most cases, it has been economical to buy standard boilers to minimize design costs and permit ready expansion.

Although we do not like to feel we are in the chemical disposal business, on some occasions a substantial saving can be made utilizing boilers for waste disposal. At several plants, waste process gases are burned with conventional fuel. Such products have heat values from 90 to 1000 Btu per cu ft, but often present combustion and control problems.

Power plant stacks can be costly in some areas, and close attention is paid to height necessary to eliminate any atmospheric nuisance. Steel, concrete and brick stacks are used, depending on cost evaluations. Often the stack can be mounted on the building and space beneath devoted to a useful purpose.

Our fuel handling equipment is conventional, but we try to integrate power house fuels with those of the plant. With natural gas, pressure reducing and metering facilities are located near points of utilization. With oil, storage facilities can usually be designed to serve power and process requirements. Storage tanks, usually above ground, are buried where space is at a premium, although investment is higher with a high water table. At one plant, oil tanks are partially buried and mounded over because of rock on the site.

Coal handling at our plants varies from a few tons to many carloads per day. Structures of coal-conveying equipment are minimized by stockpiling close to the point of consumption. Car shakers and thawing pits are installed only where justified. Possibility of using coal directly from stockpile to firing equipment should be considered under certain conditions.

Dust and Ash Handling

(Includes equipment to remove, convey and store ash and flue dust from boiler, stoker, flue, dust collector or chimney hopper to disposal.)

Investment in older coal-burning plants has been increased recently through installation of fly ash collection and disposal equipment. Later plants have been designed for such installations, but finding space at reasonable cost for this equipment is a real challenge in old plants. We try to use existing facilities, but often end up cutting holes in the roof, relocating fans and drives, and adding structural steel. Collectors add a pressure drop to existing draft losses and induced draft fans usually have to be changed—mostly confined to reworking casing, buying a new wheel, or rewinding the driving motor. When installing new equipment, we can often use the motors at some other location.

Disposal of fly ash is a major problem. Sometimes the material can be used to fill and grade existing plant sites. In at least one case we are investing money for a pipeline and sluicing system to transport ash to a distant ravine. One day quality of fly ash may have an importance rivaling that of steam quality, for its sale depends on keeping carbon content at a fairly low level. Now, most of our installations produce fly ash unacceptable for structural purposes at present standards.

Feedwater System

(Includes equipment needed from raw water inlet to boiler feedwater connection.) Investment differs greatly with water available and use to which it is put. Quality varies greatly depending on how much water must be exported to various plant operations. In textile and film operations, water must be of very high quality, and large quantities of soft and demineralized water are often required. Lower investment is possible if process needs are integrated in the power layout from the beginning.

Some processes and layouts make it inadvisable to return condensate to the power house. In some cases, possibility of contamination through leakage of heat exchangers and other equipment makes return unattractive. Sometimes heat exchangers with double-tube sheets are used to prevent such leakage. Equipment may be installed for oil filtration. Any condensate returned permits a reduction in investment otherwise required for water treatment and results in some heat pick-up.

Recently, we have eliminated a separate deaerator from the feedwater treatment plant. Softened water is adjusted to pH and pumped to a deaerating heater, performing deaeration as well as feedwater heating, with satisfactory results and a reduction of investment.

Pump house investment has been reduced in recent years. Vertical submerged pumps and minimum pump house structures are now common. At one Texas plant, pumps of this type pump river water to a canal on a plateau on which the plant is built. The canal carries water to the plant area where high pressure pumps take it into the distribution system. Providing cheap storage and a source for portable fire pumps, the canal is also less expensive than the replaced pipeline.

At some locations river levels vary nearly 50 ft between high and low water. At one plant, pumps are in a vertical caisson, the top of which ordinarily extends above high water. These pumps operate with motors flooded satisfactorily. At another plant, the pump house is built to go completely under water at flood stage.

Piping and Valves

(Includes all piping, valves, etc. other than that integral to other equipment.) As the table shows, piping investment can vary from 7 to almost 24 per cent of total power house investment. For large projects piping and valve specifications are set up at the start of design. Valves are selected for a multiplicity of service requirements and are used throughout the plant for maximum interchangeability and minimum stock. A trap and strainer standard is also set up. Traps, ordinarily outdoors, frequently must be self-draining to avoid freeze-up during shutdowns. Insulation is also specified for the entire plant and only thicknesses justified on a strictly economic and safety basis are used. Hangers are fabricated by our construction forces or purchased depending upon the price.

We try to use the inherent flexibility of the piping system rather than expansion joints or loops. It is often possible by judicious use of pipeline elevation or direction changes to eliminate some expansion facilities. If required, loops are located to take advantage of existing steel work.

Pipes are sized to normal pressure drop and velocity criteria. Occasionally, substantial savings can be made by designing for a very high pressure drop where terminal pressure is not of major importance. It is often wise to oversize pipelines where resulting greater structural rigidity permits wider spacing of supports.

Electric System

(Includes instrument and control systems.) In many industrial power plants generation of electricity is a thing of the past. Our table does not include facilities for generation. Individual electric and control devices are similar to those used elsewhere to facilitate maintenance and reduce stock.

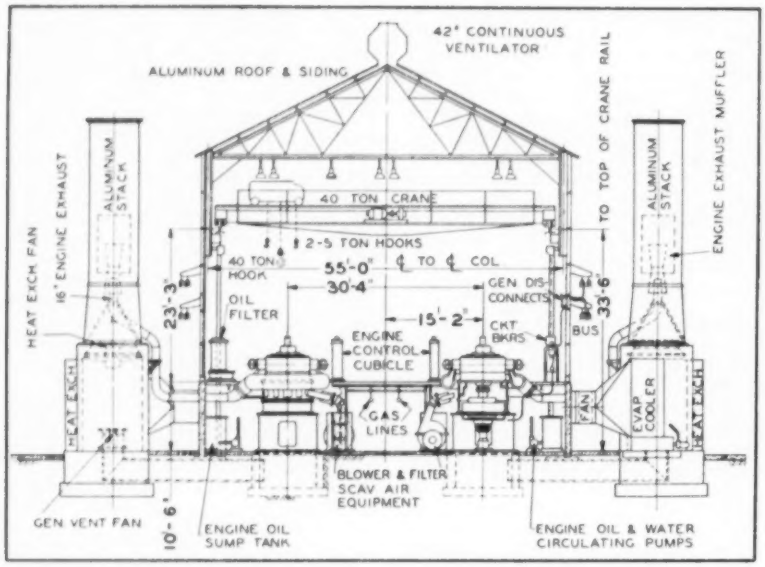
Building Investment

Recently most progress has been made on buildings. Outdoor construction is becoming common everywhere. The critical yardstick for an industrial power building requires only ruggedness, protection from the elements, and inexpensiveness.

Boilers and accessories used to be totally enclosed. Then, fans and auxiliaries were put outside; next, the rear of the boiler came through the wall; and now in some locations, the entire boiler is outside. The latter is true only in milder climates. Where boilers and auxiliaries are completely outdoors, an enclosed control room is provided for instruments, toilet facilities and water treatment equipment. Twenty-five per cent of investment cost of an originally-designed enclosed plant is involved in building. One of our newest plants, outdoors, has a building investment slightly in excess of 10 per cent.

With electric generation considerable thought has been given to shelter requirements of turbine generators. In a recent installation the turbine generator has been weather-proofed and installed outdoors with almost no

(Continued on page 127)



Cross-section of engine house, containing radial gas engines, 50,000 kw capacity; serves aluminum potline

Table 1. Details of the engines and the auxiliary equipment and their total cost for one potline

37—	Nordberg Radial Gas Burning Engines, each rated 2125 bhp, 400 rpm, with motor-driven scavenging air blowers and standard equipment
37—	Generators, 1350 kw, direct-current, 400 rpm, 40C rise, 667v, with Class A insulation and motor-operated field rheostat. Each generator equipped with slip rings to provide 150 kva alternating current at 420 v, 26 cycles, 3 phase to drive engine auxiliaries
37—	Air intake filters
37—	Exhaust mufflers
37—	Exhaust pyrometers
37—	Lubricating oil service pumps, motor driven
2—	Lubricating oil transfer pumps
37—	Lubricating oil purifiers, full flow type
2—	Lubricating oil centrifuges
2—	Lubricating oil tanks for clean and dirty oil 2500 gal capacity each
37—	Combination jacket water and lubricating oil service pumps, motor driven
37—	Radiators to cool lubricating oil and jacket water
1—	150 kw gas engine generating set complete with radiator, pumps and control panel for initial starting and emergency service
37—	Engine alarm systems
37—	Engine control panels
	Services of installation engineer and labor for complete erection
	Station piping
	Installed Cost (Engines & Auxiliaries) $7,126,000.00
	Cost per kw (Engines & Auxiliaries) $ 142.80

Aluminum Producers Get Low-Cost Radial Engine Power

GROWTH OF THE aluminum industry in North America during the past decade is, in truth, nothing short of phenomenal. There are two key factors upon which this growth is principally contingent — availability of bauxite ores, and power required for electrolytic reduction of the alumina contained therein.

Low-Cost Power a Must

Serious consideration to all companies in or entering the primary aluminum reduction field is the essential requirement of low-cost power. This requirement has been successfully met in the past either through use of energy from publicly or privately-owned power projects or by direct construction of electrical generating facilities by the individual producer. At this date, in the case of the former, most existing generating facilities are now overburdened, rates are not always economically feasible or they are in a locale that does not lend itself to construction of reduction facilities. As a result, there has been a definite trend by producers during the past several years to build and operate their own power generating plants at or near their reduction sites.

The current domestic producers of aluminum are typical of this approach. They are Aluminum Company of America, Reynolds Metals Company and Kaiser Aluminum & Chemical Corporation. The Alcoa plant near Port Lavaca, Texas during the past three years has installed approximately 220,000 kw in the form of 194 Nordberg gas-burning radial engine-generator units. With a total of approximately 350,000 hp, this is the world's largest internal-combustion engine plant. The new Kaiser plant located at Chalmette, Louisiana, currently employs 80 of the Nordberg gas-burning radial units and is now erecting a 350,000-kw steam power plant consisting of 15 Foster-Wheeler boilers and 16 General Electric turbine generators. At its new San Patricio Reduction Plant near Corpus Christi, Texas, Reynolds Metals has installed forty-two 2500-kw Cooper Bessemer turbocharged natural-gas engines and forty-one 2000-kw General Motors 16-cylinder vertical-shaft natural-gas engines for a total capacity of 187,000 kw. Reynolds, in addition, also operates its own generating plant at Jones Mill, Arkansas where eighteen 2250-kw Nordberg two-cycle gas-burning Diesels and fifty 750-kw Cooper Bessemer gas engines provide energy for aluminum production.

Most of the major producers are centralizing their operations in the Gulf Coast area of the United States. Not only are such operations close to necessary water supplies and improved transportation facilities for bauxite ore, but full advantage can be taken of attractive fuel rates made possible by ready availability of natural gas. The gas-burning radial engine was developed primarily for generating power through use of this fuel and its application for the electrolytic reduction of aluminum was discussed in a recent paper before the AIM & ME by R. W. Bayerlein, vice president, Heavy Machinery Division, Nordberg Mfg. Co.

Engines Developed for Gas

The gas-burning radial engine was introduced in 1950 following extensive research and development work and pilot model testing in cooperation with the Aluminum Company of America. They are built as a two-cycle engine with 11 or 12 cylinders of 14 in. bore and 16 in. stroke and develop up to 2125 hp, 1500 kw at 400 rpm.

Original design of these engines was detailed in POWER ENGINEERING (then *Power Generation*), November, 1948, page 78, and the first Alcoa installation of 120 of the

Table II. Detailed costs of building, foundations, related equipment for one potline's radial engines

37—Ventilating fans for building and generator cooling air, approximately 30,000 cfm each engine, and discharge fans for generator cooling air approximately 13,000 cfm each engine	$ 95,250
Lubricating oil storage and unloading facilities including two 15,000-gal storage tanks	5,000
Foundations, including concrete and grouting for engines, generator ventilating ducts, pumps, exhaust mufflers, radiators and other auxiliary equipment—54 cu yd of concrete per unit estimated at $40.00 per cu yd	80,000
1—Overhead crane, 40-ton capacity with a 5-ton auxiliary	49,500
Gas piping, outside building, including scrubbers, filters, meters and valves	14,250
Spur track to plant, trench plates, safety guards, railings and floor plates	20,000
Necessary switchgear, cables, conduits, wiring connections, equipment for grounding, feeder panels and transformers and necessary equipment for the electric starting of the engines, installed	635,000
1—Building to house engines and equipment including preparation of the site for erection of the building. Building dimensions 362 ft long by 48 ft wide by 44 ft high	350,000
Building etc. installed	1,249,000
Total Cost, Complete Plant	$8,375,000
Cost per kw, Complete Plant	$ 168

engines in POWER ENGINEERING, August 1950. Design details of the present engines were detailed in the present paper, then the following cost data were given.

Power for the Potlines

To meet the need of low cost electrical energy for the electrolytic reduction of aluminum, the radial engine has found its widest application with 274 engines in service. This extensive application can be attributed to the engine's ability to burn natural gas on an economical basis and furnish electrical energy at a cost per kilowatt hour comparable with, and in some cases lower than, hydro or steam generated power.

The low initial installation cost, as well as low operating costs, can best be visualized by analyzing a hypothetical single potline power plant for a primary aluminum reduction plant. A plant with three such lines would produce about 60,000 tons of aluminum per year. In line with the current methods of production, each potline would require approximately 45,900 kw. This study then will include all necessary equipment, including building and services, and provision has been made for sufficient standby protection in the form of additional generating facilities. This station would be set up on a unitized basis for required power protection and so that it could be expanded to meet the requirements of two or three potlines or more.

For a plant to serve one potline with these requirements, 37 twelve-cylinder gas-burning radial engines are used, each rated 2125 hp and developing 1350 kw of d-c power and 150 kw of 26-cycle a-c power for auxiliaries. On this basis, 34 engines would operate continuously to produce 45,900 kw and three spare engines per potline would be available for standby. This would give a total installed capacity of approximately 50,000 kw.

Section through the engine house of an installation of this type is shown on page 80. All engine auxiliaries are grouped for minimum piping and installation time. Exhaust stack, muffler and heat exchanger are located directly outside each engine. Parasitic power to drive the motor-driven scavenging blower, lubrication oil circulating pump, jacket-water circulating pump, generator ventilating fan, radiator cooling fan and building ventilating fan, is obtained from the a-c slip rings on the generator. Each engine generator set is a self-contained unit.

Estimated cost today of a power house including 37 radial engines complete with d-c generators and necessary auxiliary equipment installed would be approximately $7,126,000 or $142.80 per kw. A complete list of equipment is shown in Table I.

Building and Auxiliaries

In addition to the engines and auxiliary equipment, it would be necessary to supply a building complete with all appurtenances, switchgear, wiring and related items as shown in Table II. It is estimated that this additional cost would be $1,249,000. Combining the price of the engines, generators, and auxiliaries with the above cost, the overall cost is approximately $8,375,000 or $168 per kilowatt.

It has been authoritatively estimated, and our experience corroborates the fact, that a direct-current generating gas engine station can be built for a cost per installed kilowatt that is in the vicinity of the cost of an alternating-current steam station using larger individual units. In order to do this, however, simplicity of design — electrically, mechanically and with respect to auxiliaries — is a must. Of course, it should be kept in

(Continued on page 128)

Table III. Plant operating, maintenance labor costs, based on Point Comfort personnel, for radial engines

Labor Cost	1 Potline No. Men	2 Potlines No. Men	3 Potlines No. Men
Chief Engineer	1	1	1
Assistant Chief Engineer	1	1	1
Lubrication Attendant	1	1	1
Mechanical Engineer	1	1	1
Electrical Engineer	1	1	1
Operating Engineers	4	8	12
Control Room Operators	4	6	8
Engine Attendants	8	16	24
Mechanical Superintendent	1	1	1
Maintenance Engineer	1	1	1
Electrical Foreman	1	1	1
Electricians	2	3	4
Mechanics	3	6	10
Pipe Fitters	1	2	3
Helpers	3	7	11
Janitors	1	2	3
Tool Room Attendant	1	1	1
	35	59	84
Total Salaries per Month.	$13,000	$21,000	$30,000
Total kw Output per Hour.	45,900	91,800	137,700
Total Salaries (12 Months)	$155,700	$253,200	$351,600*
*(Based on average yearly salary of $4250 per person)			
Cost per Hour	$17.77	$28.90	$40.13
Cost: Mills per kwh (Output)	0.3872	0.3148	0.2914

Table IV. Estimated direct operating costs of radial engines expressed in mills per kwh. Amortization, interest, insurance and tax are not included

	1 Potline	2 Potlines	3 Potlines
Fuel Cost (10¢ Gas)	1.0500	1.0500	1.0500
Lube Oil Cost (40¢ per gal)	0.1332	0.1332	0.1332
Maintenance Cost	0.2690	0.2690	0.2690
Labor Cost	0.3872	0.3148	0.2914
Miscellaneous Cost	0.0042	0.0042	0.0042
Total Mills per kwh	1.8436	1.7712	1.7478

Surveying a typical group of 684 utility steam power plants installed from 1950 to 1953 inclusive, in various geographical sections of U. S., author finds them ranging in cost from $111 per kw to $230 per kw for indoor plants, as low as $87 per kw for outdoor plants

What Utility Steam Power Plants Cost

By HENRY DE SOTO
Mechanical Engineer

FINDING a common yardstick for present-day construction costs of public utility steam power plants, wherever they are built, seems a worthwhile task, as a guide for other engineers figuring costs. It becomes also, quite an interesting task when one realizes that at the end of the year 1950: 1, we account for 298 Class A and B utility companies; 2, we tabulate 684 steam power plants with 44,632,000 kw of installed kw capacity; 3, total assets of such utilities amounted to $20,589,000,000.

The period comprising the construction of public utility steam power plants in the years 1950 to 1953 inclusive, is a most interesting and important one because: 1 — 22,000,000 kw of new installed steam capacity will be added; 2 — over 260 new units will be installed; 3 — reheat will definitely prove its economy by claiming 15,000,000 kw in installed capacity; 4 — for the first time, boilers of 1,450,000 lb per hr rating will make their appearance; 5 — some 200,000-kw single-shaft units will be installed; 6 — the 2350-psi and 1100-F steam conditions will prove their practicality.

Geographically, the area of the nation can be divided conveniently into 7 regions as shown in color on the map. Each region will provide some comparative unit construction costs. Again, each region can be divided into the unit costs of plants of the indoor and outdoor types. We will regard the semi-outdoor type as outdoor, to avoid further sub-division. This shaded map division does not altogether agree with the Federal Power Commission map, on which it is superimposed, but is chosen as a convenient grouping for the power plant data available.

Worthwhile is the observation that operation labor has lessened in cost from 1.0 employee per 1000 kw in the pre-war period to 0.34 employee per 1000 kw in the post-war period. Of course, centralized control, automatic devices, modern design and better operation methods principally account for this noteworthy economy.

Lowest unit in the tabulation is 20,000 kw. Units 15,000 to 18,000 kw were not included.

Eastern Part of Country

New England Region: — Nine plants with 717,000 kw total installed capacity range in unit cost from $130 per kw to $204 per kw for an average of $186 per kw installed, for this region. No outdoor plants are reported contemplated in this region. Pressures range from 850 psi to 1500 psi; temperatures range from 885 F to 1050 F.

Representative utilities in this region are: New England Power Co., Public Service Co. of New Hampshire, Connecticut Light and Power Co., Western Massachusetts Electric Co., Narragansett Electric Co., Boston Edison Co., The Hartford Electric Co., Fitchburg Gas and Electric Co.

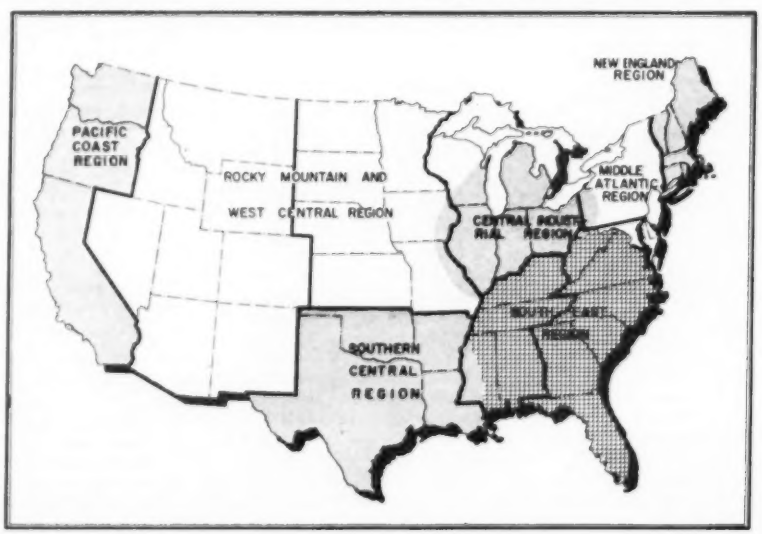
The Middle Atlantic Region: — Three plants of a large utility company with 600,000 kw total installed capacity, with reheat and semi-outdoor type construction, average $158 per kw for cost. Units purchased and under installation are: one 150,000-kw unit, one 200,000-kw unit, and two 125,000-kw units. Pressures are 1850 psi and temperatures 1000 F.

One plant of another utility, a semi-outdoor installation of 40,000 kw installed capacity, shows a cost of $221 per kw. Pressure, 1250 psi and temperature, 950 F.

Nine plants of several utilities with 1,134,000 kw total installed capacity average $186 per kw. These are indoor type. Unit costs range from $166 to $204 per kw. Pressures range from 900 psi to 1800 psi and temperatures range from 900 F to 1000 F.

Representative utilities in this region are: Philadelphia Electric Co., Public Service Electric and Gas Co. of N. J., Central Gas and Electric Co. of N. J., Pennsylvania Power and Light Co., Pennsylvania Water and Power Co., Appalachian Electric Power Co., Atlantic City Electric

Fig. 1. Map showing (in shading) author's division of seven geographical regions for an analysis of the utility steam power plant costs. This is superimposed on a Federal Power Commission map, in black, showing the geographical divisions as used in the commission's surveys of electric energy sales to consumers



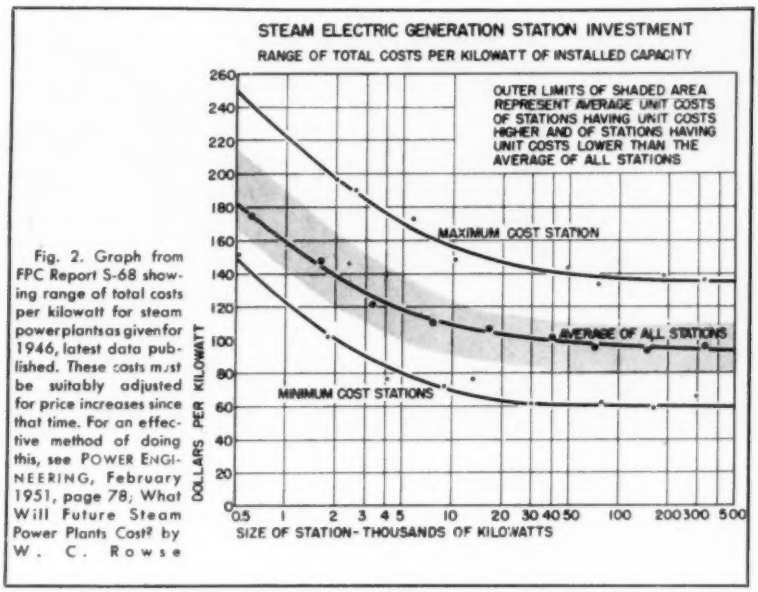

STEAM ELECTRIC GENERATION STATION INVESTMENT
RANGE OF TOTAL COSTS PER KILOWATT OF INSTALLED CAPACITY
OUTER LIMITS OF SHADED AREA REPRESENT AVERAGE UNIT COSTS OF STATIONS HAVING UNIT COSTS HIGHER AND OF STATIONS HAVING UNIT COSTS LOWER THAN THE AVERAGE OF ALL STATIONS
MAXIMUM COST STATION
AVERAGE OF ALL STATIONS
MINIMUM COST STATIONS
DOLLARS PER KILOWATT
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0.5 1 2 3 4 5 10 20 30 40 50 100 200 300 500
SIZE OF STATION - THOUSANDS OF KILOWATTS

Fig. 2. Graph from FPC Report S-68 showing range of total costs per kilowatt for steam power plants as given for 1946, latest data published. These costs must be suitably adjusted for price increases since that time. For an effective method of doing this, see POWER ENGINEERING, February 1951, page 78; What Will Future Steam Power Plants Cost? by W. C. Rowse

Co., Jersey Central Power Co., Niagara-Mohawk Power Corp.

Southeast Region: — Thirteen plants in this region with 1,650,000 kw total installed capacity, all indoor type, range in unit costs from $101 per kw to $194 per kw for an average of $172 per kw. Pressure ranges are from 600 psi to 1800 psi, and temperatures from 825 F to 1000 F.

Representative utilities in this region are: Florida Power and Light Co., So. Carolina Electric and Gas Co., Carolina Power and Light Co., Louisville Gas and Electric Co., Appalachian Electric Co., Virginia Electric and Power Co., Mississippi Power Co., Alabama Power Co., Duke Power Co., Potomac Edison Co., Consolidated Gas, Electric Light and Power Co., Delaware Power and Light Co.

Central Part of Country

Central Industrial Region: — Nineteen indoor plants in this region, with 3,883,000 kw total installed capacity, show an average unit cost of $165 per kw. Low cost per kw is $111 and high cost is $216. Pressures range from 850 psi to 1800 psi. Temperatures range from 900 F to 1800 F.

Representative utilities in this region are: Pennsylvania Electric Co., Indianapolis Power and Light Co., Duquesne Power and Light Co., Cleveland Electric Illuminating Co., Dayton Power and Light Co., Ohio Power Co., The Detroit Edison Co., Consumers Power Co., Public Service Co. of Indiana, Ohio Edison Co., Illinois Power Co., Central Illinois Power Co., Toledo Edison Co., Indiana-Michigan Electric Co., Central Illinois Electric and Gas Co.

South Central Region: — Ten outdoor type plants in this region, with 1,600,000 kw installed capacity, show an average unit cost of $112 per kw. Low cost is $98 per kw and high cost is $140 per kw.

Four indoor type plants, with 395,000 kw installed capacity, show an average cost of $136 per kw.

It is evident that this region exemplifies the economy of the outdoor type of plant construction.

Pressures range from 600 psi to 1250 psi and temperatures from 835 F to 930 F.

Representative utilities in this region are: Texas Electric Service Co., West Texas Utilities Co., Houston Lighting and Power Co., Texas Power and Light Co., Gulf States Utilities, San Antonio City Public Service Board, Arkansas Power and Light Co., Public Service Co. of Oklahoma, Oklahoma Gas and Electric Co., Southwestern Public Service Co., Southwestern Gas and Electric Co., New Orleans Public Service Co.

Western and Mountain Regions

West Central and Rocky Mountain Regions: — One outdoor type plant in this region, with 66,000 kw capacity, cost $87 per kw. Another, with four 125,000-kw units of installed capacity, shows an average unit cost of $140 per kw. Pressures are 900 psi, and temperatures are 930 F.

Thirteen plants of the indoor type, with 16 units totaling 1,050,000 kw installed capacity, show an average kw cost of $198. Unit cost in this region is quite high, with several ranging as high as $226 and $216 per kw. Low for this region is $182 per kw. Pressures range from 600 psi to 1250 psi and temperatures from 825 F to 950 F.

Representative utilities in this region are: Northern States Power Co., Kansas Gas and Electric Co., Board of Public Utilities, Kansas City, Wisconsin Electric Power Co., Iowa Power and Light Co., Kansas City Power and Light Co., Iowa Electric Light and Power Co., Union Electric Co. of Missouri, Minnesota Power and Light Co., Montana Power Co., Public Service Co. of New Mexico, Southwestern Public Service Co. of New Mexico, Utah Power and Light Co., Public Service Co. of Colorado.

Pacific Coast Region: — Three plants in this region, with 7 units of the outdoor type, total 410,000 kw installed capacity. One plant with four units totalling 310,000 kw shows a unit cost of $140. One plant with 2 units totalling 80,000 kw shows a unit cost of $135. One other plant with one unit of 20,000 kw shows a cost of $199 per kw of installed capacity. Pressures range from 850 psi to 1800 psi and temperatures from 900 F to 1000 F.

Twelve plants with 23 units totalling 2,085,000 kw installed capacity average $206 per kw. High for this region is $230 and low $160. These are all indoor type. Pressures range from 400 psi to 1450 psi and temperatures from 825 F to 1000 F.

Representative utilities are: Southern California Edison Co., Seattle City Light Co., Pacific Gas and Electric Co., San Diego Gas and Electric Co., California Electric Power Co., City of Burbank Public Service Dept.

The above data reveal the wide range of installed capacity unit costs for similar types of plants in different regions. Of note is the $87 per kw cost of a West Central and Rocky Mountain Region plant of the outdoor type, and the $230 and $226 per kw cost of two indoor type plants—the first in the West Central and Rocky Mountain region and the second in the Pacific Coast region.

Although the cost per kilowatt is intended to mean only rated installed capacity, the maximum capability of the units will, with efficient operation, reduce these figures noticeably. Again, the possible inclusion of cost of land and structures, often provided for planned future units, will justifiably result in a lower ultimate unit cost.

Corrosion Engineers Meet

NATIONAL ASSOCIATION OF CORROSION ENGINEERS held a conference during the week of March 15, 1953 at the Hotel Sherman, Chicago, Ill. Information significant to engineers concerned with protection of underground cable installations and water handling equipment in steam-electric power plants was included in the four papers given at the Electrical and Communications Symposium held Wednesday, March 18 at the Sherman Hotel, conference headquarters. For additional information contact National Association of Corrosion Engineers, 1060 M & M Building, Houston 2, Texas, A. B. Campbell, Executive Secretary.

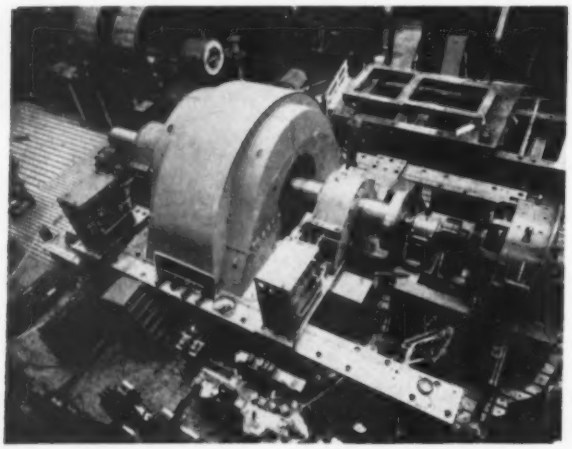
This isn't an artist's conception of a landscape, but a small wire magnified 100 times. Trees and shrubs are corrosion spots which cause wire to break

Equipment for work crews at Kemano Valley location of Aluminum Company of Canada in Kitimat, B. C. hydroelectric powerhouse is flown in by helicopter

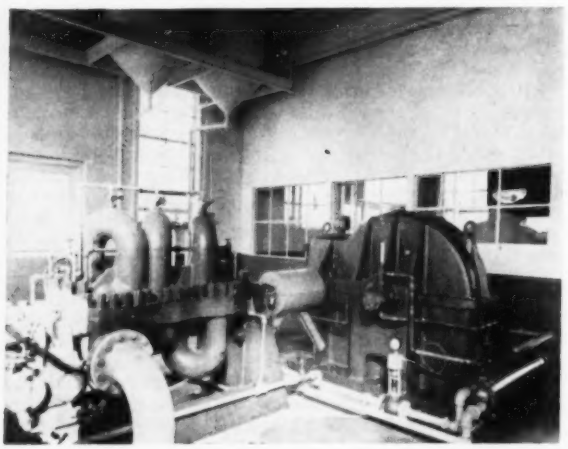
Model of 225 ft steel sphere housing General Electric's land-based atomic power plant for U. S. Navy submarines

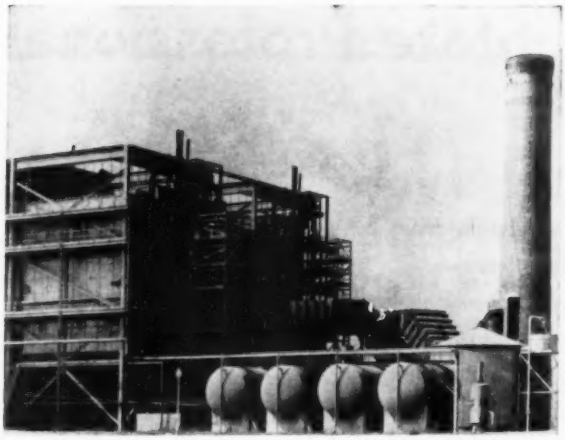
Power Engineering NEWS REEL

This 83,000-hp motor—most powerful ever built—is one of two being completed by Westinghouse for driving one of U. S. Air Force's windtunnels

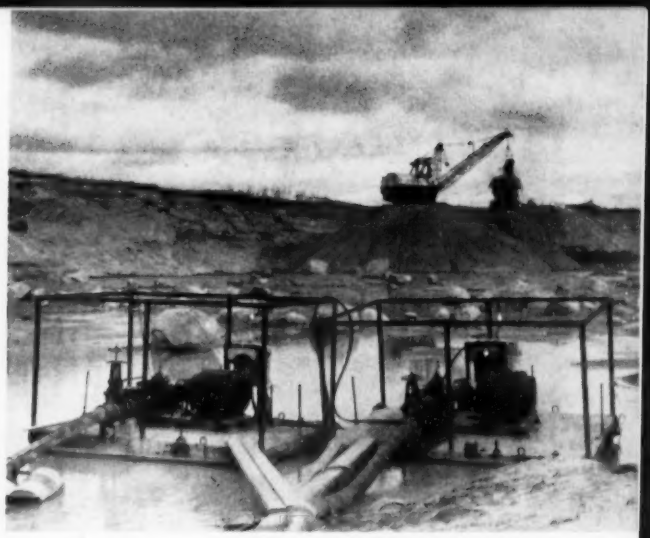


Six-stage United Iron Works centrifugal pump rated 1750 gpm at 2660 ft head, 3550 rpm in Gulf Refining Co. pumping station driven by Alco diesel





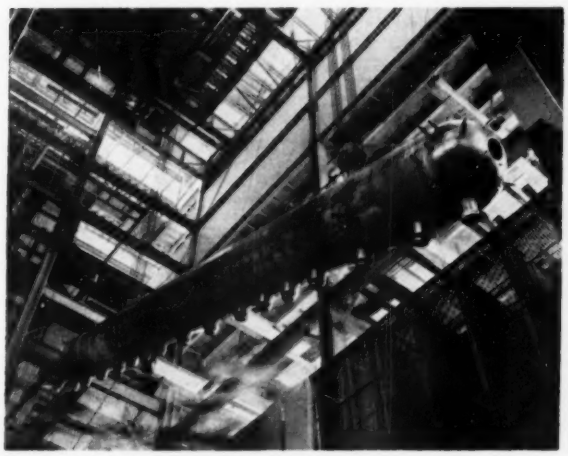
Four tanks, 12 ft dia by 20 ft long, used for condensate, surge and boiler water storage at new 60,000 kw power plant of the City of Jacksonville, Fla.



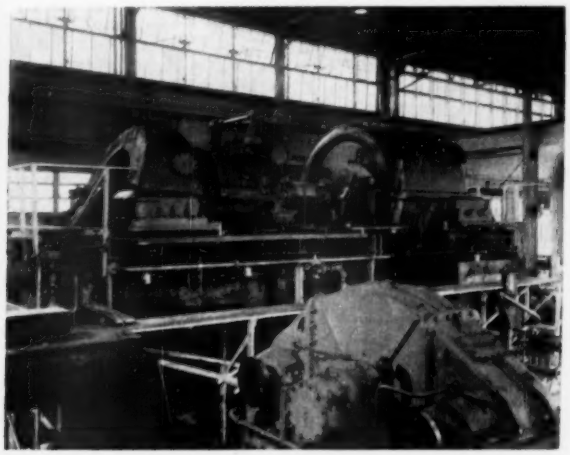
Two 2500 gpm float mounted Fairbanks-Morse centrifugal pumps driven by 250 hp motors, which run 24 hr a day at Morton Mine to keep water level low

Picture of proposed power plant in vicinity of Great Bend, Kansas, for Western Light & Telephone Co., Inc., which will be called the Arthur Mullergren Station. The station will have a General Electric turbine-generator set, Combustion Engineering boiler, Westinghouse condenser and a Marley double flow induced draft cooling tower

Steam drum for Commonwealth Edison Company's Ridgeland Station, Chicago, is 70 ft long and 6 ft in dia for new 1,100,000 lb per hr steam generator



Giant blast furnace blowers built by De Laval Steam Turbine Co. This 5-stage unit rated 121,000 cfm at 35 lb discharge pressure is driven by a turbine



How to File for N.Y. State Professional Engineer's License

By JOHN D. CONSTANCE

Consulting Engineer

Many engineers from other states are obtaining New York State licenses. . . . Other states are modeling their filing procedure on New York State's. . . . Various engineering groups are studying it. . . . This outline should be of help in simplifying and unifying licensing everywhere

PURPOSE of this article is to guide engineers who wish to become candidates for license to practice professional engineering in New York State. These instructions may be used as a guide for application by aspirants for licenses in other states. The State Education Department and Board of Examiners always retain the right to make changes to the rules.

Obtaining Your Application Form: — General inquiries and requests for application forms etc. should be addressed to:

Dr. John W. Paige, Chief
Bureau of Professional Examinations and Registrations
The University of the State of New York
The State Education Department
23 South Pearl Street
Albany 7, New York

Requests for Applications for Professional Engineer: — Your requests will be filled shortly. You will receive the following:

1 — Circular of Information.
2 — Application (White Form 1).
3 — Form 2-E, Accredited College Certification Form.
4 — Reference Form (5 copies).
5 — Record Card (white, 3" x 5").
6 — Pink business size envelope.

Applicants who present foreign credentials should apply for Form F. This includes applicants who have degrees from foreign universities.

Circular of Information: — This covers such information as: 1 — Filing dates; 2 — Examination dates; 3 — Requirements for admission to examinations; 4 — Application material required.

All material submitted must be clearly marked "Professional Engineering". Applicants may request sample question papers if applying for licensure by written examination. However, such samples normally do not cover examinations dated in any way or over extended periods.

The next examinations are tentatively scheduled for June 22nd and 23rd, 1953, and February 26th and 27th, 1954. Otherwise, examinations are held twice a year as directed by the Board of Examiners.

Application Material Required: — The applicant is responsible for filing all material, including application (White Form 1 for P.E. or Green Form for E.I.T., Engineer in Training), Form 2-E, reference forms (5), record card, foreign Form F if required and the fee. All items must be accounted for and indicated on the application. Further directions on these items will follow.

Application (White Form 1): — This form must be completely executed. It may be used by the applicant for admission to the E.I.T. as well as the P.E. examination.

Whenever possible Dr. Paige prefers that graduates use the green form for the E.I.T. examination (Parts I and II). It greatly simplifies the work of both the candidate and the Bureau.

It is necessary that applicants for Part III of the examination only complete a new application (White Form 1), including five indorsing signatures. It is usually the custom for the Bureau in the case of E.I.T.'s, when they request application for admission to Part III, to stamp their applications "Engineers-in-Training" before mailing it out to the E.I.T. candidate so applying.

If the candidate should receive a form unmarked in the above manner, he must be sure to mark it "Engineer-in-Training" before returning it to the Bureau. In any event the E.I.T. should indicate that he already has his first application on file in Albany.

Those candidates who have already taken the E.I.T. examination (Parts I and II) and have been assigned to a "retake" need not file again.

In the above case an admission card must be requested and a $5 fee submitted not later than ten (10) days before date of examination.

Engineering College Certification: — This is known as Form 2-E, and is required to be filed only by candidates who are graduates of engineering colleges and courses approved by the State Education Department.

If college is not accredited, candidate must file certified transcript of his college credits instead of Form 2-E.

If course is not accredited and the college is, the candidate must still file transcript.

Applicants who are not graduates of accredited engineering schools but are graduates of approved high schools or have partial engineering college credit must submit certified transcript of their high school record or transcript of their partial engineering college record.

Form 2-E must be sent to candidate's college registrar for final execution. A letter of transmittal and instruction should accompany this request, giving complete information as to whether graduation was by day or night school.

If by night school, candidate must file certified transcript of college credits in addition to Form 2-E.

A stamped, self-addressed envelope should be included with the request. There is usually a charge of $1 for this service by the college. Complete instructions are on Form 2-E.

Those filing Form 2-E need not file their high school transcript of record. A list of accredited engineering schools may be obtained from the Bureau at Albany. E.I.T.'s do not file Form 2-E again.

How to Get Detailed Instructions

THE AUTHOR, John D. Constance, with the approval and co-operation of the New York State Board of Examiners, has prepared detailed instructions for filling out all the forms. For example, on White Form 1 he shows exactly what to check, how to answer each question, what information to give on each item of Form 1; and the same for the other forms. Other states have comparable forms and these instructions should help in filling them out.

For a copy of these instructions write The Editors, POWER ENGINEERING, 110 South Dearborn Street, Chicago 3, Illinois or write "Professional License" on the return post card elsewhere in this issue, fill in your name and address and drop it in the mail.

Mr. Constance is author of the article How to Get Your Professional Engineer's License, POWER ENGINEERING, August, 1952. The response of readers to that article was tremendous. Mr. Constance is very active in helping engineers prepare for professional licensing examinations everywhere. He has written Refresher Notes for PE Examinations, compiled copies of past examinations, teaches refresher courses for ASME and New York University, advises leading industrial companies on helping to professionalize their engineers.

Power Engineering's

PRACTICAL ENGINEER and ELECTRICIAN SECTION

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Fig. 1. Non-adjustable fog nozzle approved by Underwriter's Laboratory for the safe use of water on fire around high voltage equipment

How Detroit Edison Company Teaches Fire Fighting

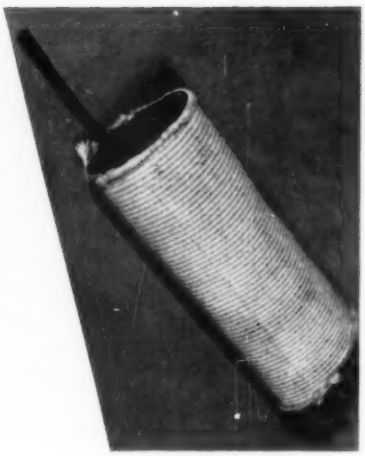


Fig. 2. A braided copper ground wire, equivalent to No. 12 Awg, built into the hose between the rubber tube and the cotton braid

In the power plants of the Detroit Edison Co., every precaution is taken by their plant protection groups to stop small fires from spreading, prevent them from starting, fight them effectively if they do start. Here are the methods they teach their fire fighters

AS CHIEF O. E. SUGDEN in charge of Plant Protection at Conners Creek Power Plant of the Detroit Edison Co., recently said in *Coal to Kilowatts:*

"We are all aware of the importance of fire protection in a power plant. A small fire can spread rapidly to all sections of the plant because of the open gratings. To prevent the extensive damage caused by such a fire, fire fighting equipment is placed throughout the plant for ready use by all of the power plant personnel.

"The Plant Protection Group work in conjunction with the Plant Safety Committee, the Safety and Fire Protection Engineer, and the City Fire Department to see that this equipment is in top shape and the best type available. The P. P. G. inspects this equipment at least once a month and does the necessary servicing."

The Plant Protection Group is also responsible for the training of plant personnel in the latest fire fighting techniques. This includes handling "first-aid" extinguishers which use water, CO_2, and dry chemicals, and training in putting out actual fires.

The plant fire brigade is equipped with special clothing to protect them against heat. Oxygen breathing masks are supplied which are safe to use in any place where there may not be enough oxygen to sustain life.

Fig. 3. A 300 lb dry chemical rig being used on a large oil fire. See Fig. 8

Fig. 4. A 2½ in. fog nozzle is used effectively with water to fight oil fire

Fig. 5. Men from all plants battle an oil fire at a fire fighting training session

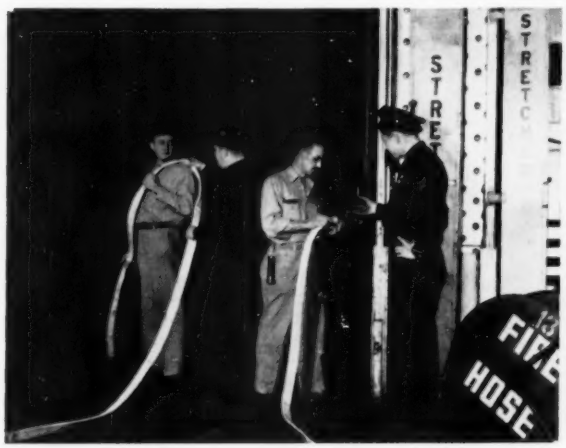
Fig. 6. A 1½ in. fog nozzle is used with water to effectively fight an oil fire

Fig. 7. Chief Sugden shows way to put on the oxygen breathing apparatus

Fig. 8. A 300 lb dry chemical extinguisher being given its scheduled checkup

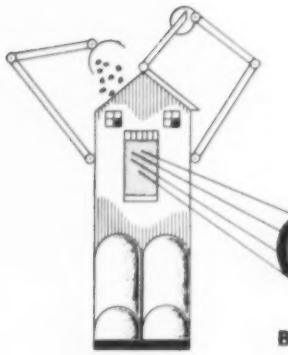
Fig. 9. Operators being instructed in the proper way of handling 1½ in. hose

Fig. 10. An operator being instructed in the use of the 30 lb dry chemical unit



Science Trends Will Not Slacken in Future

FIRST PREDICTION one can most easily make about the future is that there will be no slackening of the trends that have brought us to where we are today out of the immediate past. In fact, the rate of innovation in our economy has been accelerating. It took the steam engine a hundred years to move from being a laboratory baby to becoming a prime mover of the economic life of mankind. It took electricity only 50 years to become a part of the fabric of our economy. It took the vacuum tube 15 years. Today, the time interval between the basic discovery and its general application is shrinking down to a decade and less, said Gerard Piel, Publisher of *Scientific American*, at IRRD Luncheon at the 1952 annual meeting of ASME.



In the average power plant, materials handling usually develops along conventional lines, but occasionally there are puzzling complications requiring study. Here are just a few pitfalls to be avoided

COAL HANDLING:

By **WILBUR G. HUDSON,** Consulting Engineer

Analyzing Alternatives Lowers Operating Costs

FIGURE 1 is a layout for transferring bituminous slack from bin to stokers at a steam plant using 4 or 5 carloads a week. It consists of an L-path continuous flow elevator and a distributing screw conveyor with a capacity of about 10 tons per hr. Advantages of this layout were a comparatively low first cost and a contactor above stoker hopper No. 4 which automatically stopped both units when the hoppers were full. A push button started the units.

However, there were operating defects. If the fourth boiler was off the line, that hopper remained filled and the units could not be restarted automatically. That could be corrected by duplicate selective contactors at hopper No. 3, or at hoppers Nos. 2 and 3. Another difficulty after the stop contactor had functioned and conveyors restarted was spillage from the end of the screw onto the floor. This spillage had to be shoveled into the hopper.

But the most serious defect was corrosion of equipment by only slightly wet coal. The leg of the elevator remained filled, with the chain constantly submerged in coal. Usually life of the chain and casing sheets under these conditions would be two years or less.

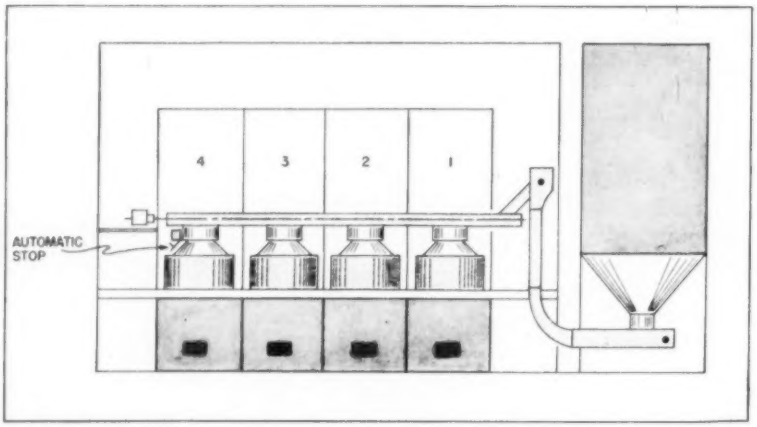


Fig. 1. A simple installation—an L-path continuous flow and distributing screw conveyor—but two defects

Consider an alternative layout with a feeder beneath the bin and a continuous flow conveyor, substituted for the screw, carrying outward in the upper run and feeding out from the return run with surplus returned to the lower end of the elevator. An automatic contactor in the return run at hopper No. 1 will stop the feeder when all hoppers are filled, but an interlocked thermal relay switch permits the units to continue for, say, 5 minutes or until they have cleared. First cost will be increased somewhat but there will be less maintenance and no hand shoveling. A casing of corrosion-resistant steel and cadmium plated chains are also helpful.

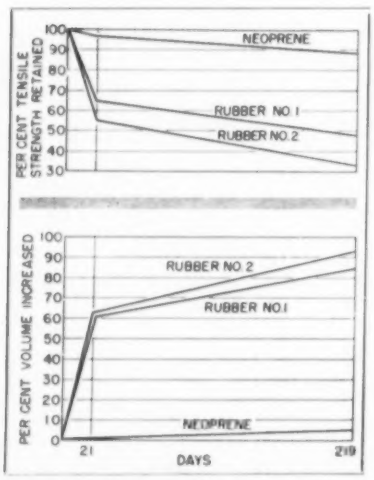


Fig. 2. Rubber shows rapid swelling and drop in tensile strength upon immersion in lubricating oil

Oil-Sprayed Coal Changes the Shape of Things

FOR A 20,000-kw utility plant in Virginia we designed a coal handling installation which included a bucket elevator and an overhead 30-in. belt conveyor on about 300-ft centers. It was a good job and functioned perfectly — at first.

Four months later there came an urgent call from the plant's chief engineer. The belt conveyor was a ghastly sight. Throughout its length, from head to foot along the carrying run, instead of the concave contour assured by the troughing idlers the belt was convex, arching sharply upward and running far out of line. Inspection of the coal gave the answer — it was oil-sprayed. The oil infiltrated the rubber cover causing it to swell and rot.

The belt was replaced by one with synthetic rubber (Neoprene) top and bottom covers. A follow-up after one year and another after two years showed it still in perfect condition.

This action of oil on rubber is well illustrated by Fig. 2 showing laboratory tests by the E. I. duPont Company. Of course, in this study the rubber was subjected to a far more difficult test than merely handling oil-sprayed coal, but it shows the necessity for specifying a suitable synthetic if oil may be encountered. In the tests the effect of immersion in SAE 30 lubricating oil at 82 F on tensile strength and volume of rubber and Neoprene was measured.

Fig. 3. Cross baffles, properly spaced, will retard flow of coal down a chute, minimizing dust problems

Angles Control Coal Flow, Stop Dust Nuisance

FROM THE HEAD of a high bucket elevator, the discharge of coal was direct to a silo, or through a bypass and long chute to a ground storage pile. The proper slope for a long chute with a carbon steel bottom plate is not too easily determined. If the coal is dropped into the chute, a slope of 35 deg will suffice to keep the coal in motion. If the bottom plate has rusted and the coal is damp, it will back up on a 45 deg slope. It is usual to fix the slope at 40 deg.

But in this case the coal was dry and very dusty. It shot out of the chute at a velocity which caused considerable scattering of dust, and of course, the gremlins saw to it that the wind invariably was blowing toward the power house windows when coal was being handled.

The difficulty was ended by bolting angles across the chute floor, spaced by trial until a suitable retarding action was obtained, as shown in Fig. 3. This system eventually allowed a very gentle discharge.

Incidentally, if a chute is found to be too flat and material will not flow, a correction is a sheet of thin (14 or 16 gage) polished stainless steel bolted to the bottom plate.

How Guaranteed Coal Storage Capacity Can Shrink

GUARANTEED capacity is a phrase with troublesome aspects. It is more likely to cause difficulties to the seller than to the buyer. For instance, a silo-type concrete bin with a steel cone top was specified for 400 tons coal capacity. Bituminous coal has an angle of repose of 35 deg, and the cone top was sloped accordingly. But when coal, especially damp coal, is chuted into a bin it piles up at 40 or even 45 deg, so that in this case when incoming coal reached the peak of the cone there remained substantial unavailable capacity.

In another instance a silo, with an upper live-storage section formed by a floor sloped at 45 deg, was specified as having a live-storage capacity (above the shelf) of 75 tons. Only about $\frac{2}{3}$ of the required capacity would flow out, however, because coal along the perimeter of the discharge opening rested on a non-flowable slope of about 30 deg. The contractor had to add 10 ft more to the silo wall and extend the elevator, no doubt at his own expense.

In both cases the contractor should have specified capacity in cubic feet.

Continuous Flow, Fluid Coupling and Shear Pins

THE CONTINUOUS flow conveyor or elevator does a good job when not misapplied, but it has limitations. One conveyor for molybdenum concentrates — highly abrasive — had a life of 3 months and was replaced by a special screw conveyor. An elevator for wet sewage sludge received this sticky material without protest, but a hard deposit was built up on the duct faces and jammed the unit. A bucket elevator would have also failed.

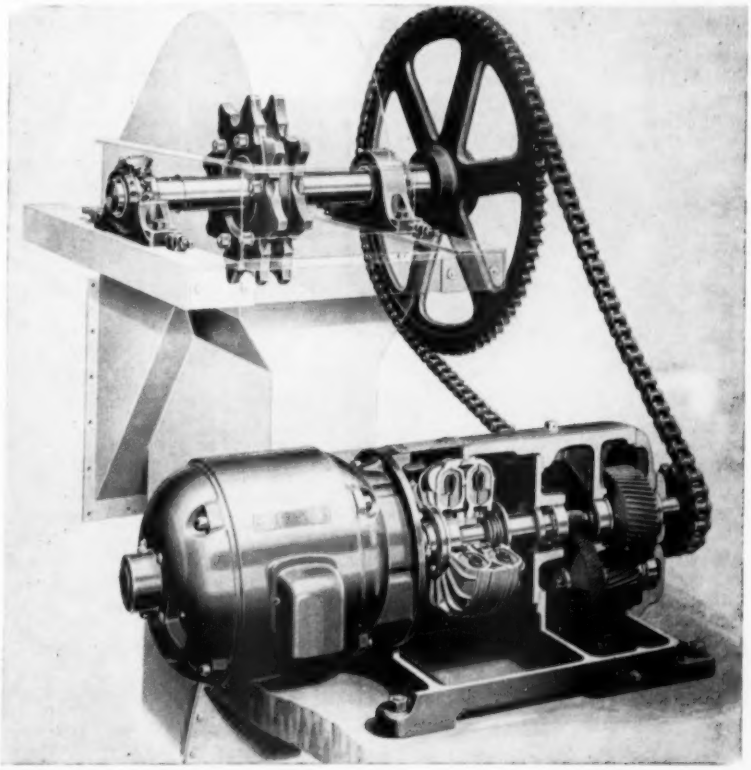
A continuous flow unit provides substantial reduction in invest ment and simplified layout, frequently calling for one unit instead of two or three.

One smoothly-operating installation for handling material from trucks included a vertical bucket elevator discharging to a short flight conveyor. The elevator required 40 hp and the conveyor 5 hp. Drive was a single 50-hp motor with an overload relay adjusted to let go at a current surge corresponding to about 25 per cent overload. One day a chunk of tramp iron jammed the conveyor at the end of a run. The elevator was nearly empty so the 50-hp motor poured about 10 times the power it was designed for into the conveyor, and wrecked it.

A shear pin installed in the drive prevented any recurrence. Such a mounting should be arranged so the motor will stop when the pin lets go.

As a protective device, the shearing pin is losing favor to the fluid coupling, Fig. 4. In event of a jam the coupling will pull maximum torque of the motor and draw off sufficient current to cause a thermal relay to function after a few seconds.

Fig. 4. Hydraulic coupling with thermal relay in motor circuit gives full protection to elevators or conveyors



How To Figure Chimney Sway Graphically

By PAUL ROGERS

Consulting Engineer

I HAVE READ, with considerable interest, William H. Engelman's article on the design of natural-draft chimneys [1]. This article described, in concise terms, the basic fundamentals of brick chimney design.

It may be of interest to many readers to extend the chimney calculations to deflection computations, i.e. the movement in inches of the top of the chimney in one direction and perpendicular to the vertical axis. A chimney can be considered to react as a cantilever beam—a member with one end projecting beyond the point of support, free to move in a horizontal plane under influence of loads (in this case wind, or wind-force) placed between the free end and the support.

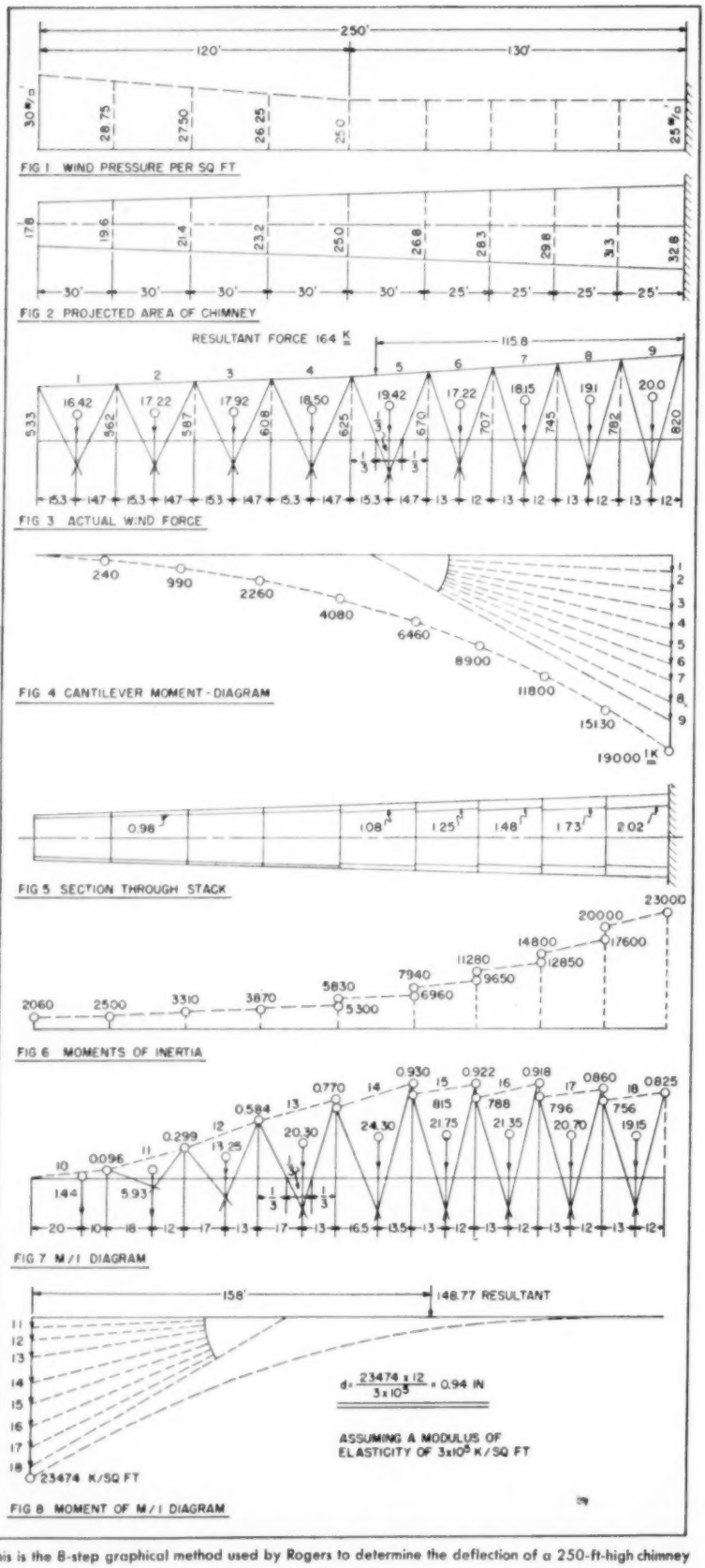
A few months ago I was called upon to compute the maximum horizontal deflection of a 250-ft high chimney. It was mandatory that the deflection should not exceed 1 in., because an inter-station short-wave radio transmitter antenna (microwave) was to be attached to this chimney. Proper functioning of this antenna could not be maintained if deflection was excessive.

Due to the tapered dimensions of the chimney and the variable moments of inertia (area of a projected segment of the chimney multiplied by the square of that segment's distance from the axis of rotation, usually), a semi-graphical solution was adopted. Figures 1 through 8 show this solution. Through accurate drafting, an experienced designer can compute such a deflection in a minimum of time.

Figure 1 shows the wind-pressure diagram. A pressure of 25 lb per sq ft was assumed up to a height of 130 ft, with increasing pressures up to 30 lb per sq ft at the top. Figure 2 shows the projected area of the chimney. Figure 3 presents the actual wind-force, which is the area times the pressure, or Fig. 1 times Fig. 2. This actual wind-force is divided into 25- and 30-ft segments; values and centers of gravity of each segment are established; and the location and value of the resultant force registered.

Figure 4 shows the cantilever bending moment diagram about the base. Figure 5 shows a longitudinal section

[1] Basic Power Plant Figuring — How To Figure Size and Mechanical Design of Natural-Draft Chimneys, page 75, December, 1952, POWER ENGINEERING.



This is the 8-step graphical method used by Rogers to determine the deflection of a 250-ft-high chimney

through the stack, indicating the changing wall thicknesses. Figure 6 presents the moment-of-inertia diagram based on the variable wall thicknesses. Figure 7 is the M/I (stress) diagram, which is in effect Fig. 4 (cantilever bending moment) divided by Fig. 6 (moment-of-inertia diagram). This diagram is again divided into segments and their values and centers of gravity are established.

Figure 8 presents the moment diagram of the M/I diagram (Fig. 7). In order to obtain the actual horizontal deflection, the maximum value of Fig. 8 (23,474 kips per sq ft[2]) should be divided by the modulus of elasticity of the brickwork as shown in Fig. 8. This varies from 1,500,000 lb per sq in. to 5,000,000 lb per sq in. Assuming a conservative value of 2,100,000 lb per sq in., or 300,000 kips per sq ft, a final deflection of 0.94 in. is obtained.

The foregoing system can, of course, be used to advantage for the deflection computations of steel stacks with tapered dimensions and variable plate thicknesses.

[2] One kip equals 1000 lb.

Occupational Hazard— Electric Burns and Shock

By DR. W. SCHWEISHEIMER

ELECTRIC BURNS are mainly of two types: those produced by heat of the arc which occur when the body touches a high-voltage circuit; and those caused by passage of electric current through skin and tissue. Short circuits, live and bare wires most often cause occupational burns among electricians, linemen and others engaged in electric power production.

In addition, burns usually are classified in three degrees. A first degree burn may cover a large area of reddened and unbroken skin. A second degree burn is similar to a scald —the skin is blistered and broken. In a third degree burn tissue is burned away. Dr. Jelinek, an expert of electrical accidents, reported a case where current was strong enough to actually char flesh at the elbow where only a small amount of flesh exists. Second and third degree burns should always be attended by a doctor.

It is commonly believed that more severe burns are caused by alternating current than by direct current. However, Dr. Hart Ellis Fisher, after 20 years of experience with more than 1000 cases of electric burns, does not believe type of current is responsible for severity. It is true that direct currents contain lower voltage, but burns seem just as serious from low as from high voltage.

Next to bone, skin is most resistant to electric current. That is why burns are almost always present in electrical accidents. Some skin lesions from such burns appear punctate or like a bullet wound. Deep burns extend into tissues below the skin, into muscles and even bone.

Special Treatment

Electric burns bear little resemblance to burns from other forms of heat. They need particular treatment. The wounds are usually painless, dry and aseptic. They assume circular, linear and tubular form. Skin surface is usually grayish and hard, and hairs nearby are not damaged. These burns frequently seem only superficial, but within a few days they may get worse.

Arcing of the electric current produces tremendous heat, giving the wounds their characteristic appearance. Degree of injury depends upon voltage, amperage, length of exposure, size of the point of contact and resistance of the skin. Points of entrance and exit of the current generally show greatest injury.

Dry skin is resistant to electric current. A damp surface, i.e. wet skin, a better conductor, offers less resistance but tends to spread the injury over a large area with less serious results. Degree of the skin lesion may depend on age of the worker, whose skin becomes dry with advanced years. Electric burns heal completely, although healing is slow.

Drs. Schwartz, Tulipan and Peck warn of neglect in treating small, superficial burns which has often led to serious complications. They recommend conservative treatment to prevent this possibility during the second or third week. Skin grafting may even be necessary after severe burns.

Short Disability

As a rule disability after electric burns is short unless there are complications. Dr. R. T. Johnstone has stated that it is sometimes difficult to convince persons injured by electricity that they have not been seriously injured. He does not mean those persons who show hysteria or malingering, but rather a small group who believe electric shock is a devastating business. The long experience of electrical workers shows that such fears have little foundation.

Electric burns of the mouth, however, are highly unpleasant. They are not uncommon with small children, while not so frequent among industrial workers. Taking of food may be difficult and pain is severe.

Electric burns may frequently be treated like other burns. If shock accompanies the burn, best treatment is to keep the patient warm (not hot), give him sweet drinks, and reassure him of quick recovery. Use of narcotics in such cases will depend on the presence of a doctor.

Experts recommend that for first measure, while the wound is still dry, the burn should be covered with a well-chosen ointment and light bandages of gauze. Infection can be kept to a minimum by intelligent first aid methods which avoid any uncleanliness. The wound or part of the gauze which will cover the burn should not be touched.

Later, doctors will clean the surrounding skin with soap and water and use compresses for one or two days, followed by sterile, dry dressings. Aim of the careful cleansing is to eliminate bacteria on the burnt surface and surrounding skin.

Improved Treatment

Great improvement in treatment of extensive burns is the closed dressing, first proposed by Drs. Siler and Reid, and generally adopted after its merit was proved in the Boston Cocoanut Grove disaster in 1942. The closed dressing, infrequently changed, allows healing of most burns mild or deep, in 7 to 28 days. Possible infection can be prevented or minimized by preventive doses of penicillin.

Dressings are planned not as mere cover, but for two special reasons. First is to reduce risk of infection as much as possible. Second is to reduce oozing from the burn. For the same reason, compresses are under light pressure — firm but not tight.

Recently good results have been obtained from the use of ACTH, the hormone of the pituitary gland that stimulates the adrenal glands to manufacture cortisone. Pain, restlessness and shock disappeared after its use in cases of severe burns.

A bland or anesthetic ointment is helpful in relieving pain. Quite a few substances have been recommended. Satisfactory results have been obtained with castor oil, tannic spray, petroleum jelly, tannic jelly, gentian violet solution, etc. In cases of electric burns the intake of fluids and salt solutions is helpful. Water, tea, coffee, carbonated beverages, etc., should be offered regularly to the injured, provided they are conscious.

Electric burns can be expected where the worker is by the very nature of his job exposed to short circuits, bare and live wires. But burns can be minimized by more care before they are likely to happen, and by a better understanding of their characteristics and what to do for them.

Fig. 1. Strain gages used to weigh heavy casting. Method can be used for other heavy equipment

Using Strain Gages in the Power Plant

STRAIN GAGES are finding practical applications in several ways around the power station. They can be used to measure the contents of tanks containing fuel oil, big machine parts and also for coal hopper weighing. Figure 1 shows an instance where strain gages are being used to weigh a very heavy casting. The gages may be applied in this manner for many kinds of heavy equipment. But first, where did the idea come from, what is this type of gage and how does it work?

Lord Kelvin discovered in the latter part of the last century that if an electric conductor is subjected to a stress it changes its electrical resistance as a function of the stress applied. The electric conductor which in this case is a fine filament is embedded in a cement matrix, and as seen in Figs. 2 and 3, the little wires are cemented in place and insulated from the material underneath by some insulating medium—usually a piece of paper or a layer of bakelite. This filament is normally a wire one-thousandth of an inch in diameter or smaller, running back and forth forming a grid pattern to give adequate length and resistance. A typical grid may measure ¼ in. long by 3/16 in. wide and have a resistance of 120 ohms. It is attached to substantial lead wires by soldering or welding.

Since this gage is bonded to the material to which a strain is applied, the filament changes its electrical resistance in proportion to that strain. The problem is merely to measure the change of resistance—two to three tenths of one per cent—as it appears across the gage terminals. This is done by connecting the filaments in the form of a Wheatstone bridge circuit as shown in Fig. 3.

The Westinghouse Electric Corporation uses a strain gage known as the SR-4 type which they are applying in several ways, two of which are described in the following text.

One way they are using the strain gage is for load measuring devices such as hopper weighing. This is shown in Fig. 4. In this set-up is shown a typical hopper layout having a supply hopper and a weighing hopper. The latter is supported on load cells and may, if desired, be automatically operated by the weighing instrument. At the right is a Streeter-Amet weight printer that gives a record in terms of printed numbers.

Another application is shown in Fig. 5 where the gages are used to measure the contents of a tank. At each end, the tank is supported by transverse I-beams. The I-beam at the right is in the nature of a hinge or flexure support. At the left is a similar I-beam which transmits the load to a pair of strain gage load cells. The beam which extends axially is merely a support to tie it so it can't slip off its foundations in that direction. This is perhaps as simple an application as can be made and still give reasonable accuracy. Should you want the highest accuracy, support the entire tank on four or more load cells. With this type of installation, you could have the calibrated meter for reading the load in the control area, even though the tank may be remotely located.

Fig. 3. Right. A typical transducer which transmits strain to the gage. Note the arrangement of the filaments and also the Wheatstone bridge circuit

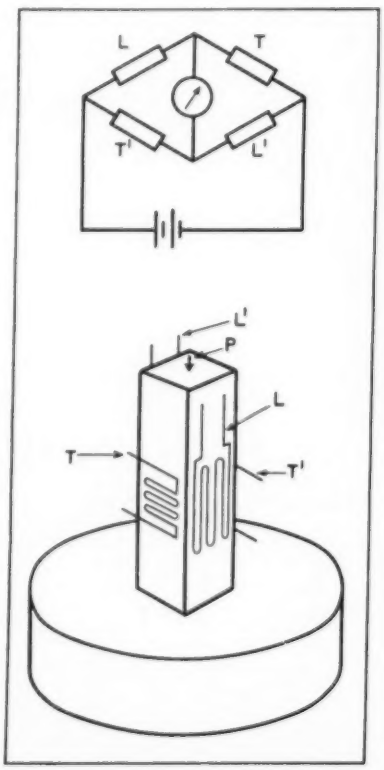
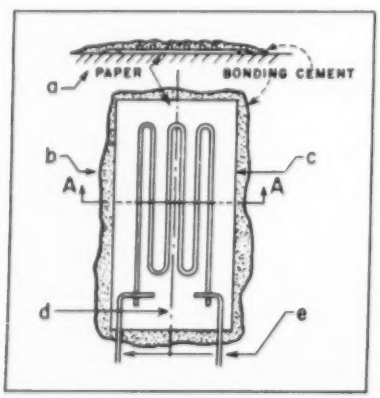


Fig. 2. Typical SR-4 strain gage. a—cross-section view, b—bonding cement, c—paper base, d—the strain sensitivity axis, e—two heavy lead wires



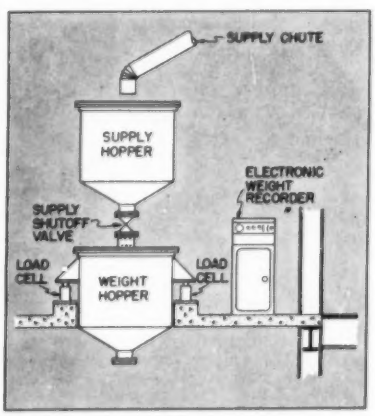
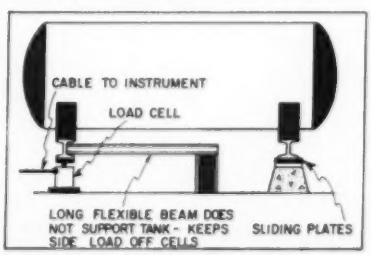


Fig. 4. Above is shown a typical coal storage and weight hopper arrangement using strain gages

Fig. 5. Below. Application of strain gages for measuring the contents of a fuel storage tank



Hydraulic Conversion Factors

AT PRESENT, many nomographs and tables are available for obtaining the friction, velocity, and friction head for fluids in standard (Schedule 40) steel and cast iron pipes. Few, if any, data are readily available for plastic lined, plastic, and light wall steel pipes.

Time, a vital factor in preparing estimates and specifications, has been invariably lost in checking different handbooks to find correct hydraulic conversion factors. The table included here, prepared by Stanley Lenox of the Permutit Co., is an attempt to make friction, velocity and friction head data available for engineers, who must deal with the flow of liquids or fluids in other than standard steel pipes.

The table is based on the following widely accepted relationships:

1 — Velocity is inversely proportional to the area or pipe diameter squared
2 — Velocity head is proportional to the velocity squared or inversely proportional to the pipe diameter to the fourth power
3 — Friction loss is inversely proportional to the roughness coefficient C to the 1.85 power and the pipe diameter to the 4.87 power (Williams & Hazen formula). C is usually taken as 100 in designing steel and cast iron pipes, and most tables are based on this value.

The inside diameters listed in the table are those currently used by manufacturers such as American Hard Rubber Co. and the United States Rubber Co. The roughness coefficients are those usually assumed for the particular material in question. Blank spaces indicate sizes in which a complete line of pipe and fittings is not currently being manufactured.

Although the materials listed are those in widest use at the present time, the factors shown apply to any pipe having the same inside diameter and roughness coefficient.

Problem: Determine the friction loss through 350 ft of 1½ in. Saran-lined steel pipe carrying 30 gpm of water. *Solution:* From *Cameron Hydraulic Data* or the *Permutit Data Book*, or other table, loss per 100 ft of 1½ in. Schedule 40 pipe, C = 100, is 11.1 ft. From the table of hydraulic conversion factors shown here, correction factor is 1.30. Therefore, the friction loss equals 350/100 x 11.1 x 1.30. The answer is 50.5 ft of water.

Table showing hydraulic conversion factors for plastic pipe, plastic or rubber-lined pipe, light steel pipe

To obtain velocity, velocity head, or friction loss for pipes listed below, take value for Schedule 40 pipe (C = 100) and multiply by factor in table

Type of Pipe	Hydraulic Property	Nominal Pipe Size—Inches										
		½	¾	1	1¼	1½	2	2½	3	4	5	6
Schedule 10 Steel C=100	Vel.	0.853	0.872	0.916	0.916	0.919	0.922	0.881	0.883	0.892	0.906	0.910
	Vel. Head	0.728	0.754	0.836	0.840	0.841	0.842	0.773	0.783	0.799	0.826	0.828
	Friction	0.677	0.711	0.804	0.808	0.810	0.813	0.731	0.746	0.760	0.790	0.795
	Pipe I.D.	0.674	0.884	1.097	1.442	1.682	2.157	2.635	3.260	4.260	5.295	6.357
Rubber Lined Sch. 40 Steel C=140 ⅛" linings for 4" and under ⅜" linings for 5" and 6"	Vel.	.....	.....	1.72	1.49	1.41	1.30	1.24	1.19	1.14	1.17	1.14
	Vel. Head	.....	.....	2.97	2.23	1.97	1.67	1.54	1.40	1.29	1.36	1.29
	Friction	.....	.....	2.02	1.42	1.22	1.01	0.907	0.814	0.734	0.782	0.733
	Pipe I.D.	.....	.....	0.799	1.130	1.360	1.817	2.219	2.818	3.776	0.672	5.690
Saran Lined Sch. 40 Steel C=140	Vel.	.....	.....	2.33	1.68	1.44	1.50	1.31	1.24	1.23	.....	1.23
	Vel. Head	.....	.....	5.43	2.85	2.06	2.25	1.72	1.55	1.52	.....	1.51
	Friction	.....	.....	4.21	1.91	1.29	1.44	1.04	0.916	0.894	.....	0.889
	Pipe I.D.	.....	.....	0.687	1.0625	1.344	1.687	2.156	2.750	3.625	.....	5.469
Uscolite (U. S. Rubber Co.) C=140	Vel.	1.29	1.23	1.20	1.17	1.15	1.13	.....	.....	.....	.....	.....
	Vel. Head	1.69	1.52	1.44	1.36	1.33	1.29	.....	.....	.....	.....	.....
	Friction	1.01	0.895	0.842	0.779	0.759	0.733	.....	.....	.....	.....	.....
	Pipe I.D.	0.55	0.742	0.96	1.278	1.50	1.94	.....	.....	.....	.....	.....
Saran & Parian (Amer. Hard Rubber Co.) C=140	Vel.	1.29	1.23	1.20	1.17	1.15	1.13	1.18	1.16	1.15	.....	.....
	Vel. Head	1.69	1.52	1.44	1.36	1.33	1.29	1.38	1.36	1.33	.....	.....
	Friction	1.01	0.895	0.842	0.779	0.759	0.733	0.800	0.781	0.758	.....	.....
	Pipe I.D.	0.546	0.742	0.957	1.278	1.500	1.939	2.277	2.842	3.749	.....	.....
Hard Rubber (Amer. Hard Rubber Co.) C=140	Vel.	1.54	1.44	1.25	1.22	1.26	1.22	1.20	1.24	1.15	1.12	1.16
	Vel. Head	2.40	2.07	1.57	1.49	1.58	1.47	1.45	1.55	1.33	1.27	1.35
	Friction	1.55	1.30	0.932	0.870	0.933	0.863	0.847	0.916	0.758	0.721	0.776
	Pipe I.D.	0.500	0.687	0.937	1.250	1.437	1.875	2.250	2.750	3.750	4.750	5.625

How to Use a Carbon Arc Burner in Battery Repair

LEAD BURNING is becoming increasingly important in battery maintenance programs as industry becomes more alert to the economic advantage of more careful treatment of the primary energy sources which drive so many lift trucks, tractors, shuttle-cars, other industrial vehicles and station batteries for automatic operation of switchgear. Lead burning (welding) may be done with an acetylene and oxygen torch or with a carbon burning outfit. The latter uses electric power from the battery being repaired and involves the simplest equipment. The following instructions and precautions are part of the Gould-National Batteries current plus-performance plan.

The carbon burner consists of an electrode holder and a carbon rod. It is designed for six volts (three cells of a battery) as its power supply. It is a common error to use the carbon burner on either fewer or more cells, the former being inadequate for making a good weld, the latter actually endangering battery, operator and joint.

The burning tool may be connected either directly to the battery being worked on or to three cells of an adjacent battery.

The rod is pointed to a ⅛ in. tip and is permitted to extend from the holder to a length of about 1½ in.

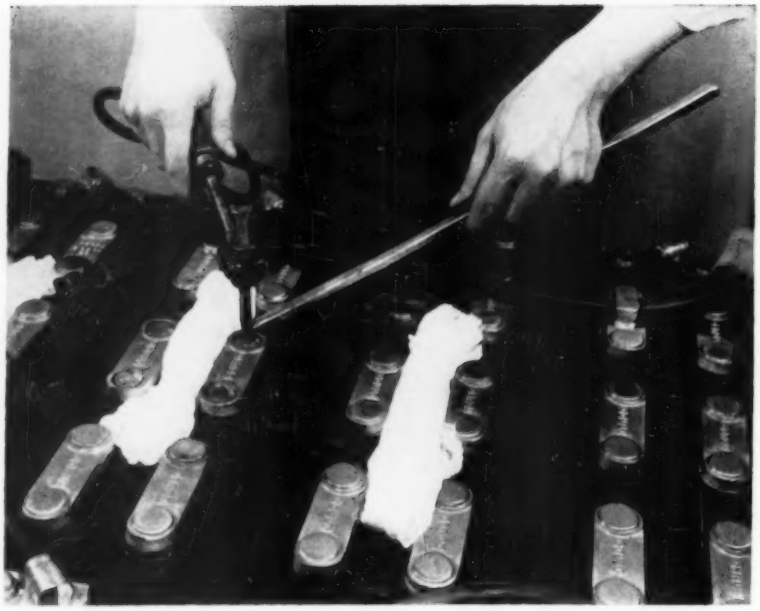
When possible, it should be connected to its power source so that the carbon rod is of negative polarity. This makes welding easier as it tends to keep the joint and working surface clean. The lead surfaces to be welded must be clean. A wire brush may be used for this purpose after the surfaces have been neutralized. The inside hole of a connector may be cleaned with a knife. The tip of the carbon should be wire-brushed before starting. Dark glasses are recommended for the operator.

The secret of making a good joint is to have clean materials and a hot carbon. The technique calls for thoroughly heating the center of the part being worked until a puddle of molten metal exists. Only then may additional lead be added. Work rapidly to complete the operation before the entire part melts. When possible use a damp rag to surround the part being worked on. When building up posts or splicing a connector, use molds made for the purpose.

After making a burn, allow the joint to cool undisturbed. In cooling the lead will shrink slightly. Do not move or disturb the joint during cooling; this may cause the lead to crystallize and result in a poor joint.

When working within a mold, it is necessary that the carbon should not touch the side of the mold.

To determine whether a weld has been properly made it is wise to test with a pair of pliers (after the joint has cooled) to see if the joint will strongly resist separation. If separation occurs, examine the two surfaces to determine the points and nature of weakness so that situation can be corrected on the second try.



View of a connector being burned to a battery post. Fresh lead is being applied to the rod so that it flows down the rod into the puddle. The damp rags are being used to prevent damaging any adjacent parts

When adding new lead to a joint, touch the new lead to the carbon rod and let it flow down into the puddle rather than to plunge cold lead into the puddle itself.

In burning a connector to a post, one slow trip around the post should be sufficient to make a satisfactory weld. Although the same is true of burning a post to the lead-insert of a new cover, the depth of the joint is such that considerable lead will have been removed from the post in the single slow circuit around the joint. Therefore, the carbon point should be returned to the center of the post and new lead added to raise the post height up to the level of the top of the post mold.

PRACTICAL HINTS AND KINKS

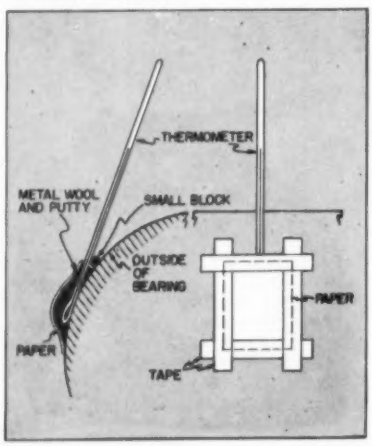
Simple Way To Take Accurate Bearing Temperatures

By H. NYE JOSLEYN

ACCURATE BEARING temperatures can be taken by affixing a straight-stemmed thermometer to the bearing surface and enclosing the thermometer bulb in suitably conductive material.

First obtain a small ball of metal wool about $\frac{5}{8}$-in. in diameter. Copper or brass wool is best, although steel wool can be used satisfactorily. Mold enough ordinary window putty into the wool to fill the spaces and make a solid ball. Lay this mass in the center of a 2-in. square of heavy wrapping paper.

Next place the thermometer in the desired position on the bearing and, keeping paper to the outside, press the metal wool-putty ball firmly onto the thermometer bulb. Apply enough pressure to make a firm union of putty, bulb and metal, but not enough to flatten the putty. Leave about $\frac{3}{8}$-in. of putty at the outside and bottom of the bulb beneath the paper. A small block of wood under the stem near the bulb will help hold the thermometer in place.



Metal wool, ordinary putty and wrapping paper can be used to fasten straight-stemmed thermometers to bearings for close temperature readings

Use tape to fasten the square of paper to the bearing surface. At ordinary temperatures plastic electrician's tape is ideal for this purpose. On higher temperature surfaces it is often advantageous to use gummed paper tape.

Tape along the bottom of the paper square first. Then fasten the sides and top. Additional reinforcing strips can be used depending upon position and weight of the thermometer.

Accurate readings, aided by heat transfer of the wet putty can be obtained at once. As putty bakes hard and the thermometer tends to become permanently fixed to the metal, equally good results can be obtained.

Saw Speeds Concrete Floor Maintenance

CONFRONTED with frequent floor patching and maintenance due to heavy wheel traffic, Consolidated Water Power & Paper Co. now uses the newly developed method of sawing before breaking of worn or damaged areas in concrete floors.

The perimeter of the damaged area is sawed about one quarter the slab depth, to provide a plane of weakness for faster, neater air-hammer breakout. Breakout fracturing is confined within the sawed area, leaving the surrounding area completely free of hidden fractures.

Questions and Answers

Your fellow engineers will answer your power engineering questions. You answer theirs, get paid well. Simple? Effective? Why don't you try it?

Question No. 506

What Can He Do About This Coal Silo?

THREE YEARS AGO, on two separate occasions, we had serious fires in our coal silo. The silo is of baked-tile, hollow-wall construction. Today the silo is deteriorating rapidly and is becoming a costly repetitive job of tile replacement and tuckpointing to keep it in good repair.

Whether or not the fires were the cause of this deterioration we do not know. Our immediate concern is how to correct the condition.

If you or any of your readers have any information on how to solve this problem or if you can put us in touch with someone who has had this experience, we will appreciate that, or any other information you may have to offer to help us solve this problem.

Indiana J. G. S.

Answer No. 502

What Has Been Your Experience With Fuel Oil Sludge Solvents?

Fuel oil treatments enter the picture as an aid for efficient steam generation due mainly to continual refinery changes from older style thermal cracking to modern catalytic crude cracking which produces residual fuels with a higher Btu content and also a greater sludge content. In times of residual fuel shortage especially during winter months, many suppliers are forced to furnish oils with heavy sludge that in normal times would be dumped to waste.

"Cat" cracked fuel has heavy uncracked residue and accumulation of non-volatile materials of petroleum derivatives, including asphalts, gums, resins, dirt and traces of scale. Typical analysis, although varying with different refineries, is about 85 per cent carbon, 13 per cent hydrogen and the remainder consisting of the above mentioned sludging impurities.

Some of these impurities are kept in continual suspension but most settle to tank bottoms when moisture condenses due to the breathing action of the air space above the oil level in storage and handling, descending through the oil, picking up the suspended and near insoluble material which then becomes sludge at the tank bottoms.

Many make-shift remedies have been tried by plant operators without success including benzene, kerosene, petroleum solvents, ether, alcohol, carbon tetrachloride, and other chlorinated solvents to loosen these deposits.

A large number of chemical compounds are offered today under various trade names. Chemical composition varies, some being coal tar distillates; fuel oil distillates mixed with kerosene and petroleum sulfonates; napthalene mixed with fuel oil distillate and certain complex alcohols and oil solvents. It should be understood that these fuel oil additive compounds can hardly be classed *atomic* in action, it still not being possible to turn a full tank of sludge into perfectly burnable oil.

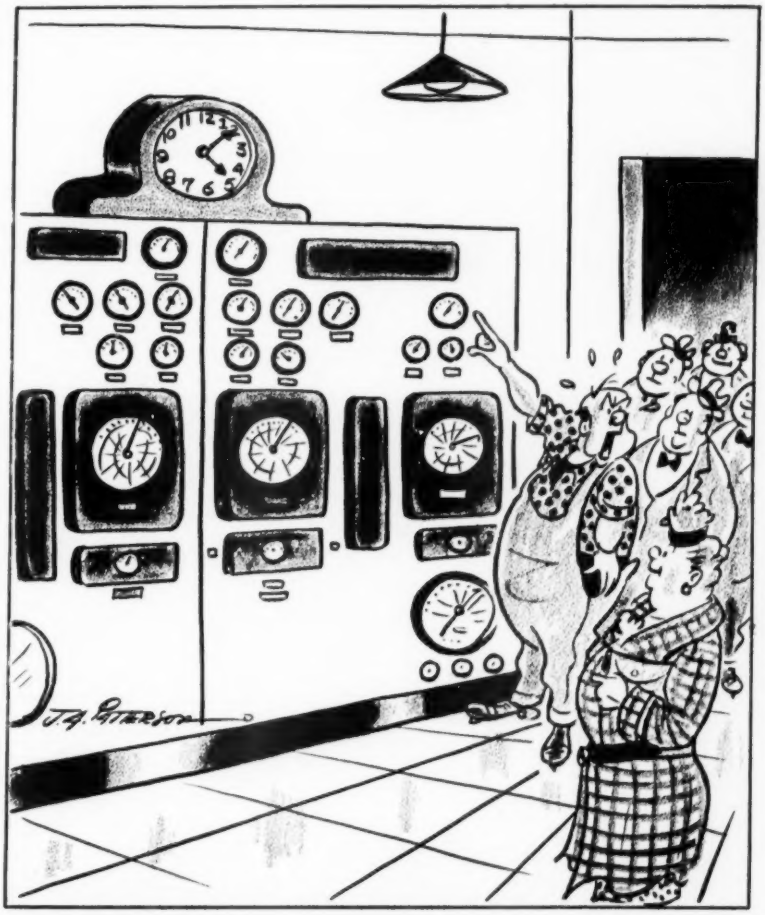
To be successful any sludge treatment must lower the interfacial tension causing the sludge to flatten out, which is similar to milk homogenization. The sludge is then dispersed and distributed evenly and permanently through the oil in storage. Most compounds are so blended that the water in the sludge is gradually picked up and dispersed minutely so that it will not interfere with proper burning.

None of these compounds should be used without making this simple test:

Place a small portion of the fuel oil treatment offered in a small dish. Add a bit of sludge and an instantaneous reaction should take place with the sludge going immediately into solution. One of the most important requisites for any fuel oil treatment is its solubility in fuel oil. Unless completely soluble, it will not function—so, try another treatment.

The additive should be checked for pH and a neutral range near 7.0 is most desirable as low pH will cause souring of the oil and high pH may be due to non-combustible organic materials.

Best results are obtained where the sludge accumulation is small and to use ample treatment and limited



"And that last one—the one on top—is for telling time; it reads 10 minutes past my quitting time!"

new oil to assure sludge deposit being acted on by the greater concentration of added additive. Often the initial charge is not sufficient to complete the job and additional treatment must be introduced continually to completely remove all sludge deposits.

Percentage of treatment recommended by various suppliers ranges from 0.015 to 0.03 per cent of the tank capacity with material ranging from $1.75 to $6.50 per gal. Amount usually recommended figures at one pint to one quart for each 1000 gal of oil. However, a safer figure to use with any sludge deposit is one gallon to 100 gal of oil which should produce noticeable results within 24 hours.

However, the actual amount can only be determined by the results which are noted after treatment has been applied. Sludge in the tank will disintegrate and the moisture remains suspended. Excess water is minutely picked up, dispersed in the oil and the foreign matter and scale being freed from the sludge will find its way through the oil lines to the strainers. Frequent cleaning of strainers will indicate when the sludge disappears and the rate.

Treatment can be poured directly into the storage tanks and agitation by an air pump at low pressure (not exceeding 5 psi) will efficiently distribute the treatment. This air circulation is not always necessary since the additives in themselves will usually permeate through the oil stock. With viscous and concentrated sludge, agitation of the mixture with a motor and connected paddle may be absolutely necessary.

Trouble can also occur with the incorrect application of the treatment. Treated oil in storage with the introduction of fresh oil, lowers the solvent percentage and sludge can precipitate. Remedy is to use constant regulated control of treatment at all times.

First sign of sludge in an oil burner system is lowered temperature of oil from pre-heater to burners; higher steam consumption to adequately heat oil to normal temperature for firing. This comes several days before any sizeable quantity of sludge accumulates in a tank. After starting treatment, first sign of better oil supply is steadier flame without hissing; next, higher temperature oil from pre-heater and lower steam demand by pre-heater

Centrifuges have also been used for separating sludge and water from No. 6 oil, but while mechanical means are not often helpful in keeping sludge from tank bottoms, they cannot overcome the need for chemical treatment and its action that will completely emulsify water and sludge and put it again in complete solution.

The Navy and the majority of large merchant vessels in addition to chemical fuel treatments, use a system of settling tanks where the oil supply is initially unloaded to one set of tanks equipped with suitable waste drains and allowed to thoroughly settle for 24 hours. It is then pumped to the main storage tanks.

When any fuel tank is emptied quickly, the residual sludge usually does not have a chance to settle because agitation keeps the sludge in motion and solution. However, it will sometimes continue to other parts of the system.

Probably the simplest means of detecting sludge is through an inexpensive water detector which is an electric indicator detecting the ohms resistance breakdown of the oil dielectric which occurs when water forms in a tank bottom and means sludge can form.

Unloading oil directly from the dome of tank cars with suitable strainers rather than the lower valve exits will eliminate the possibility of picking up sludge from the bottom of tank cars.

Installation of a 2000 gal house tank, similar to a day tank in a diesel plant, will materially reduce moisture condensation from hot burner oil returns cascading back to colder outdoor storage tanks. The added advantage of using this hot return oil from the burners for recirculation to the burners lowers daily steam demand and cost for preheating the burner supply through preheaters since about 25 per cent of near burner temperature oil will be flowing to the tank instead of the colder oil from outdoor storage tanks.

The necessity for using a fuel oil treatment can be graphically seen from the following tabulation:

Percentage Yields from a Barrel of Crude Oil

	1910	1920	1930	1940	1950
Gasoline	10.7	26.1	42.0	43.2	44.0
Kerosene	33.0	12.7	5.3	5.7	5.6
Fuel Oil	33.6	48.6	40.2	38.6	38.4
Lubricating Oil	10.7	5.7	3.7	2.8	2.5
Residual Loss	12.0	6.9	8.8	9.7	9.5

As refiners continue to extract more gasoline and other light products from the raw barrel of crude oil, the residual oil will continually become harder to handle due to the heavy accumulated heavier forms of carbon, but will still provide more Btu per gallon for the plant operator, and eventually fuel oil treatment will involve control tests much as the steam engineer now finds necessary in water treatment.

Jefferson City, Mo. L. W. FITZPATRICK

Answer No. 504

What Changes Are Needed to Drop Heating Steam from 125 psi to 15 psi?

THE FIRST REQUIREMENT would be to install new low pressure pop safety valves. For steam heating boilers ASME code requires safety valves of the spring loaded type which cannot be set for a pressure greater than 15 lb per sq in. The size is determined from the grate area as indicated in the code. However, as boilers operating over 100 lb pressure require a greater relieving capacity for safety valves than for boilers operating under 100 lb, you would be safe in using two of the same size (3½ in.) 15 lb safety valves as are now being used for 125 lb pressure.

The non-return valves will operate on any pressure and need not be changed; they function as cushioned check valves with a screw for keeping them closed as required.

New steam gages should be installed, calibrated at twice the rated pressure, 0–30 lb.

All steam reducing valves should be removed from the steam lines. If these are large valves and the cost to remove them would be prohibitive, it is only necessary to remove the operating mechanism from inside the valves so that the low pressure steam will blow through without any reduction in pressure.

If the reducing valves are located a long distance from the boiler steam header, it may be necessary to increase the size of the old high pressure piping between the pressure reducing valves and the main steam header, making it the same size as the low pressure piping on the other side of the regulator.

The heating system will not have to be changed as this is already operating on 5 lb pressure, which can be obtained by regulating the main steam valve as required. To prevent wire drawing, this valve should be a globe valve.

Condensate from both the vacuum returns and gravity returns should discharge into a condensate receiver and be pumped from the receiver to the boiler, by a float operated motor driven, low pressure, centrifugal condensate pump. This is to replace the high-pressure steam-operated, duplex, reciprocating piston-type boiler feed pump commonly used for this purpose.

A city water line can be connected directly to the boiler for emergency use, but it would be more desirable to control the boiler feed through a float valve into the condensate receiver.

Then the simplest way to find the boiler output in pounds of steam would be to install water meters and thermometers in the return line to each boiler. With one pound of water being converted into one pound of steam at a given temperature, it should be a simple matter to measure the temperature of the water and convert the gallons of water as shown on the meters to pounds of water and into pounds of steam.

Last but not least, if you are using a factory steam whistle, there will not be enough steam pressure to operate it and it may be desirable to operate it with compressed air.

Sunbury, Pa. GEORGE H. HILL

LETTERS TO THE EDITORS

Refractories, Spooks, Water

FIRST — LET ME compliment you on the February 1953 issue. Perhaps it is because the topics refer to subjects with which I am most concerned but I found it extremely interesting.

Second — in your June 1952 issue you were kind enough to publish some of my remarks on horizontal expansion joints in the refractory lining of hrt boiler settings. After a series of delays due to a strike in the manufacturing part of the Danvers plant and other conditions having nothing to do with the boiler house, two hrt boilers were equipped with settings designed in the manner described in the June issue. That is, they were built with a ½-in. layer of paper board in the horizontal joint of each fifth course in the inner 4½ in. of the refractory lining, and they were put into regular service about three weeks ago.

In place of a horizontal crack about ¼ in. wide in the red brick of the side wall about four or five feet above the floor of the furnace, there is a barely perceptible opening of a horizontal joint at about that level. This more or less bears out our calculation, for we made the paper board strips a little thinner than the calculations indicated, to avoid the possibility of permanently open joints on the inner face of the furnace wall in case our data on expansion coefficients of red and fire brick proved incorrect.

Third — Spooks and Gremlins in Our Power Plant by A. E. Richards, on page 79, contains the answer in his gas analyses of steam impurities — the CO_2 content. I have seen very similar conditions: pipes grooved along the bottom as though a stream of acid had flowed through them; and nuts on the valve studs of vacuum pumps half eaten away. I would not give too much importance to the variation in amount of gas determined at different locations in the lines, because when you come to tenths of a part per million you are doing some pretty accurate measuring.

If the boiler compound they are now using contains soda ash or other carbonates, it would be better to substitute caustic soda and phosphate. If the CO_2 comes from gas in the feed-water, which is not removed in the deaerator, an amine such as cyclohexylamine, henzylamine or morphaline, the choice depending upon the pressure and operating characteristics of the system, would neutralize the CO_2 and reduce the corrosion.

Fourth — Water treatment engineering by L. W. Fitzpatrick on page 74 requires much the same comment as in the preceding paragraph. Several of Mr. Fitzpatrick's prescriptions include soda ash, which decomposes in the boiler to caustic soda and CO_2 which goes out through the steam and can cause considerable trouble. I think he would be better advised to substitute caustic soda to provide the desired alkalinity, and phosphate to precipitate his calcium compounds.

New Haven, Conn. H. D. FISHER

Spooks and Gremlins

THE ARTICLE, Spooks and Gremlins in Our Power Plant, in the February issue, was interesting in that we have experienced two of Mr. Richards' ghosts in our own plant.

The wood that was cooked in the steam line is a duplicate of an almost similar thing that happened in our plant. The partly deteriorated wood particles and larger pieces completely choked the trap lines at the 20-in. low-pressure main and very nearly caused damage to our heating system before the trouble was found. I might add that because of the nature of the wood particles the trouble was not completely remedied on our first clean out. The particles started to show up 3 years after the work was done. The line operates at 5 psig.

The other culprit, as Mr. Richards calls it, was his corrosion or "your guess is as good as mine" trouble. We have overcome our difficulty. In the past we were compelled to change a section of pipe 6 ft long every 6 months. The corrosion (?) was as described: like little worms drilling into the pipe in some spots and eating away of the threads in another spot, leaving the skeleton thread intact. Corrosion, electrolysis, O_2, CO_2 or what have you, we stopped it. The last pipe renewal was made 1½ years ago.

What did we do? Drove a brass rod 2 ft down in the ground, placed a copper clamp around the iron return pipe and connected the clamp to the brass rod with copper wire. Guess we drove the O_2 out — or was it CO_2?

We were advised by several water treatment salesmen to do something about it and quick, or we'd have plenty of trouble. Maybe sulfite would have done it too. At least we could have spent a lot more money by using sulphite.

Maybe, Mr. Richards, maybe. You call it culprit; water treatment salesmen call it O_2; deaerator salesmen call it CO_2. I call it cured.

Princeton, N. J. MARVIN E. RULE

REFERRING to A. E. Richards' problem, page 79 February POWER ENGINEERING, perhaps the following will be of help.

We had the same trouble he is having but after using a filming amine in our boiler water this trouble has been reduced by at least 60%.

Several large reliable water treatment concerns have these amines for sale and they all do the job. The concerns I have in mind advertise regularly in POWER ENGINEERING and if Mr. Richards will contact one of these firms he can discuss this problem with them. In a short time his troubles on this score will be history. The cost is truly small considering what can be accomplished by this treatment.

Electrolysis may be partly to blame but CO_2 and O_2 are probably the worst "gremlins."

Four things to be done, to help eliminate these culprits, are:

1. Shift to caustic in place of soda ash if the latter is now being used to control alkalinity in the boiler water;
2. Be sure deaerating heater is amply vented;
3. Keep feed temperature above 220 degrees;
4. Carry 30 ppm of sulphite in the boiler water.

Massachusetts G. F. SPENCER

P.S. I have no connection of any kind with the water treatment business.

Boom Intake

THAT DESIGN for a new type of intake screen, explained by George Rodemeyer in the Feb. issue, should arouse considerable interest and I imagine considerable controversy.

To keep down cost per installed kilowatt of capacity, it would be fine if the entire screen house structure could be simplified as shown in Mr. Rodemeyer's sketches, especially by elimination of a good deal of the deep screen chamber. It seems to me the whole success of the idea depends on the construction of the "boot".

It depends on something else that interests me very much as an operating man. That is: How much maintenance work will be required on the boom intake, and will such maintenance be easier or harder on the boom intake than it is on a conventional type screen?

Mr. Rodemeyer infers that boom intake maintenance would be easier but he does not give details. And of course, you can't give details until you know just what problems will come up. The only way to find that out is to have a full-scale installation and try it out for some time.

I hope Mr. Rodemeyer will be able to get such an installation built and hope you will keep us informed of the results.

Dallas, Texas PAUL BASKIN

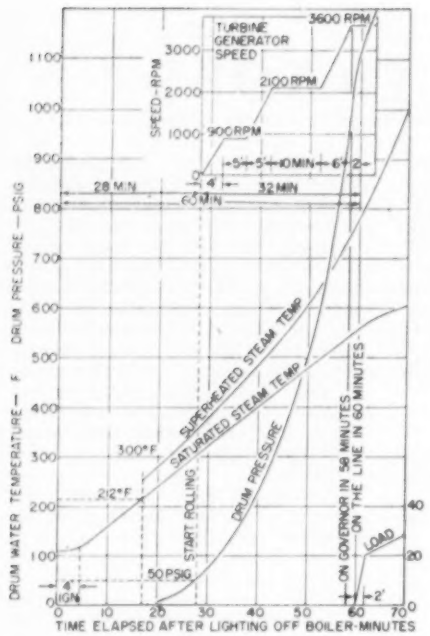


Fig. 1. Basic one hour starting schedule for a unit boiler and condensing turbine after 48 hr week-end shutdown

Quick Starting of Large HP, HT Boilers

To take advantage of new and more efficient power stations during week-end load drops, Consolidated Edison began quick starts from cold of large, high-pressure, high-temperature boilers. Tests showed this was not only feasible but also resulted in fuel savings

IN THE NEAR FUTURE Consolidated Edison's generating stations will be faced with routine 24 and 48 hr week-end shutdowns of large, single unit, high-pressure, high-temperature turbines and boilers. As a result of week-end load drop and opening of the new Astoria Station — with heat rates roughly 20 per cent better than those of existing plants — the annual number of starts-from-cold on high-pressure boilers will greatly increase. It is with this situation in mind, together with a conviction that quick starting from cold, when properly handled, is less rigorous on expanding boiler structures than present 5 to 6 hr starts, that this investigation was carried out.

Test results show safe operating procedures can be developed to bring 1,000,000 lb of steam per hr boilers equipped with high-pressure drop superheaters from a cold condition to on-the-line in 1 to 2 hr. Investigation disclosed operational techniques and fundamental concepts relative to such accelerated starts, and data on handling both topping and condensing turbines in this connection.

Starting tests were conducted on 9 boilers of 4 very different designs. Some boilers were on a unit system with a topping turbine; some on a unit system with a condensing turbine; and some on bypasses to lower pressure systems. Gas and metal temperatures and expansion movements were taken by careful and strategic placement of thermocouples.

Design and operation considerations of unit-system, high-pressure, high-temperature boilers, prior to these tests, have been concentrated on the range of capacity from 30 per cent maximum to full output. Practically no performance data has been published in the range from zero to 30 per cent maximum. This is particularly true in the pre-output range which begins with light-off and ends with synchronizing of the generator.

During the early part of the work, it was conceived that — following a week-end shutdown — a boiler, with its companion turbine, could be started from cold in a total elapsed time of 60 min from light-off to on-the-bus. Proposed typical start or pre-output zone performance is shown graphically in Fig. 1. However, because such an operation involves a rate of saturated steam temperature increase of 400 to 500 F per hr — or 4 to 5 times as large as was generally accepted prior to 1950 — reduction of starting time was brought about gradually. Successive shortenings were undertaken only after analysis of data covering the previous start had demonstrated soundness of the operation.

Factors under close observation during these starts were:

(1) Overheating of the superheater element metal in the gas passages.

(2) Thermal stresses in drum structure resulting from non-uniform heating of the drum by water and steam along its length, in the head, and across the drum wall.

(3) Expansion of the entire boiler structure.

Superheater Tests

Results obtained on superheater metal temperatures, during quick starts-from-cold of 1 to 2 hr duration on 4 different designs of boilers and superheaters, establishes that with high-pressure drop superheaters and with proper control of firing, superheater metal can be operated during starting period within safe temperature limits and without resulting in shortening of normal superheater element life.

This statement has been proved correct for five cases involving different boiler and superheater arrangements and synchronizing at different steam flows.

It can be concluded that quick starts-from-cold can be made with complete safety of superheater metals, and with negligible moisture carried to the turbine for the cases not tested; namely that of partially and completely non-drainable superheaters which are flooded prior to starting and which deliver steam to condensing turbines.

EDITORS NOTE — This article presents the highlights of a paper by Jefferson C. Falkner, Manager of the Power Production Dept., Consolidated Edison Co. of New York, Inc. on Quick Starting of High-Pressure, High-Temperature Boilers (Paper No. 52-A-120) given during the Power Session of the Annual ASME Meeting in New York, December, 1952. One of the meeting's most interesting and important contributions, the 153-page report represents several years' work and extensive tests by the engineers of the Consolidated Edison Co.

The results seem to controvert a long-standing operating reluctance to start steam equipment fast; and they will increase in importance as more and more utility systems find a need for unit selectivity to gain efficiency during week-end and other light loads. To meet the nation's increasing demand and carry ever-higher peak loads, utilities will come face to face with this problem very soon.

Safe superheater operation conditions prevail during a quick start-from-cold for the following reasons:

(a) There is a relatively low heat release rate on the furnace.

(b) There is an enormous heat absorption rate in the boiler cold water walls.

(c) Temperature of the gas reaching superheater tubes is low, once correct firing rate has been established, because of (a) and (b).

(d) Whenever metal temperatures occur which result in stresses above Code allowable values, they are of such magnitude and short duration that they have no effect on normal tube life.[1]

(e) Superheater tubes are subjected during the start to low pressure stresses. Because there is little or no steam flow through the superheater, thermal stresses in the tube wall are negligible.

Drum Metal Stresses

The heavy wall drum is the part of the boiler structure most likely to be adversely affected by higher rates of temperature rise during quick starting. One authority has said that the 100 F per hr rate of saturated steam temperature increase has been given in power plant operation an authority which cannot be upheld.[2] In addition, after referring to field test work on drums up to $8\frac{5}{8}$ in. thick, he concluded that "If each part of a drum of any thickness is held within 100 F of any other part, the maximum stress in the drum will remain within allowable limits."

Thicknesses of the drum sheet of the boilers tested varied from a minimum of $3\frac{13}{32}$ in. to $5\frac{3}{16}$ in.

Tests showed that quick starting of existing large high-pressure boilers from a cold condition results in drum stresses which are equal to or less than those prevailing under starts of long duration — except for extreme ends of the drum where stresses are higher, but within Code allowable stress values. Results of one such test are shown in Fig. 2. There is also definite promise that drum-end stresses can be reduced by simple changes to internal baffling, or possibly by introduction of small circulating eductors operated off feed pumps of the unit.

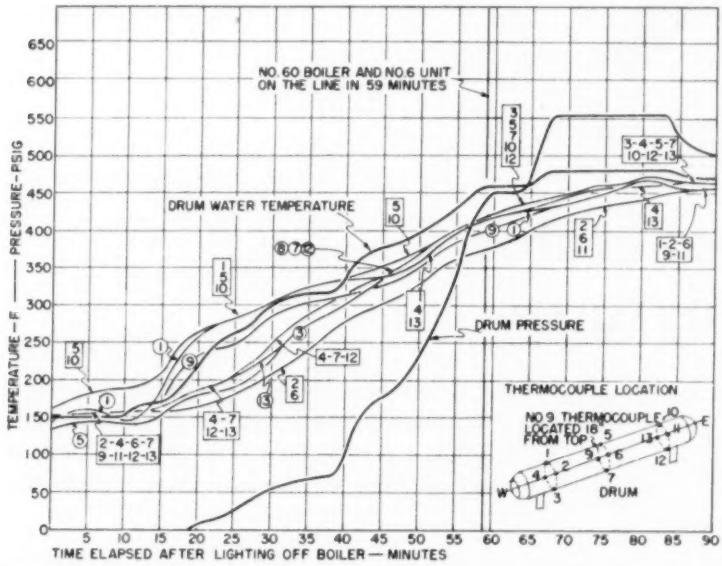

NO. 60 BOILER AND NO. 6 UNIT ON THE LINE IN 59 MINUTES
DRUM WATER TEMPERATURE
DRUM PRESSURE
THERMOCOUPLE LOCATION
NO. 9 THERMOCOUPLE LOCATED 18 FROM TOP
DRUM
TEMPERATURE — F —— PRESSURE - PSIG
TIME ELAPSED AFTER LIGHTING OFF BOILER — MINUTES

Fig. 2. Chart shows drum metal and drum water temperatures and drum pressure during quick 59 min start on boiler at East River Station. Locations of thermocouples on drum during test are shown at right Table shows fuel consumption from light-off to on-the-bus for both quick and long starts during recent tests made by Consolidated Edison. Percentage of Btu saved by quick starting is given at far right

	Boiler Number	Time in Minutes	Cu Ft of Gas[1]	Gas Oil[2]	Tons Coal[3]	Corrected Total Btu[4]	% Btu Saved
East River Station							
Quick Start	60	59	16,000	0	9.7	263,240,000	26.8
Long Start	50	242	67,000	0	12.1	359,628,000	
Waterside Station							
Quick Start	90	59	300,000	0	5.2	301,896,000	44.6
Long Start	90	240	650,000	0	8.7	545,659,000	
Sherman Creek Station							
Quick Start	100	90	112,400	2,284	0	353.630,000	42.9
Long Start	100	340	601,100	0	10.9	620,172,000	
Hell Gate Station							
Quick Start	11	59	314,658	190	0	363,670,000	42.0
Long Start	11	256	546,734	497	0	627,476,000	

[1] Hell Gate uses straight natural gas at 1065 Btu per cu ft. All other stations use mixed gas at 540 Btu per cu ft.
[2] 150,400 Btu per gal at Sherman Creek; 150,310 Btu per gal at Hell Gate.
[3] 13,432 Btu per lb at Sherman Creek; 13,140 Btu per lb at East River; and 13,520 Btu per lb at Waterside.
[4] Corrected to equivalent quick start initial and terminal temperature conditions.

Boiler Expansion

Downward expansions of boilers were measured during all starts to determine relative movements resulting from both quick and long starts.

Measurements were taken at the lowest points of the boilers. Zero readings indicate position of the reference points when the boilers were cold. On any individual start, divergence of the curves with respect to each other indicates different degrees of expansion which can be interpreted as a measure of boiler structure distortion — or if provision is in the original design — a measure of the working of expansion joints. If it is assumed that the boiler is under minimum strain when cold, then these divergent expansions represent structural stress which may be superimposed upon pressure and thermal stresses.

It has been shown that quick starting of cold boilers results in more uniform thermal expansion. Uniformity of expansion is a distinct advantage in any structure. In the case of boilers this may well contribute in lessening maintenance.

Operating Procedure

Operating procedures for bringing a cold boiler (room temperature) and a relatively cold turbine[3] to synchronization are simpler and less subject to hazard than the long start because: first, intermittent firing with its alternate heating, cooling and upsetting of circulation is eliminated; second, a constant rate of temperature rise is substituted for the operator's personal idea of when and how long he should be firing or not firing; and third, with the operator's attention not focused on starting and stopping of fuel feed and air flow, he has more time to concentrate on uniformity of boiler performance.

To eliminate addition of one man to the start-up crew of new centralized control installations where operating crews are small, a sufficient number of blowdown valves and also drum vent valves should be motorized and controlled from the central room to give instant control over level and venting.

Fuel Consumption

Other advantages accrue from quick starting after week-end shutdowns, such as an increase of 15 per cent in time available for week-end maintenance and a small fuel saving.

(Continued on page 156)

[1] Low carbon material on which a high stress was encountered, 3700 psi at 1000 F, has a probable continuous operation lifetime of 40,000 hr at that stress. Thus, starting from cold 50 times a year for 50 years would total only 1250 hr of that lifetime.

[2] Savoye, Executive Assistant, Babcock & Wilcox Co., N. Y.

[3] Details of quick start method were given in the article, Quick Starting of High-Pressure Steam Turbines, by J. C. Falkner, R. S. Williams and R. H. Hare, Consolidated Edison Co., in the December 1947 issue of POWER ENGINEERING.

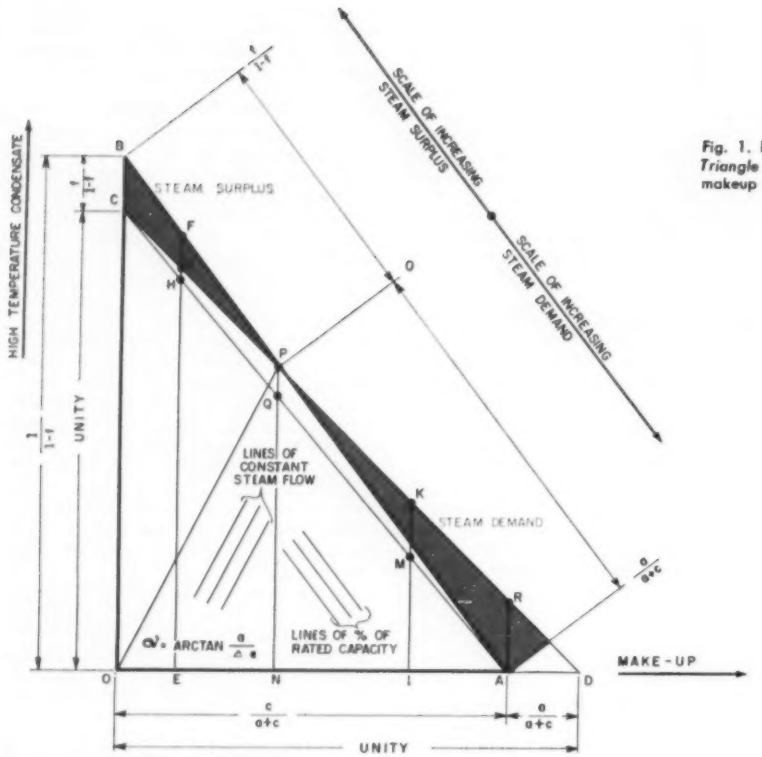


Fig. 1. Development of a typical *Heater State Triangle* for three mass flows—condensate, makeup and steam—one liquid a flashing mixture

Graph Your Deaerator For Flashing Mixtures

By FREDERIC R. ALEX

Mechanical Engineer, Republic Flow Meters Co.

A typical deaerator heater with three mass flows, one a flashing mixture, is analyzed; and adequate heat balance set up; new Heater State Triangle derived to find component flows graphically

IN TWO PREVIOUS articles [1], this writer presented a graphical method for obtaining heat balance figures of deaerator heaters of the direct-contact type with three or four component flows participating in the heat exchange process. The method presented was based on construction of an adequate *Heater State Triangle* derived from a heat balance equation, with the result that values of conjugated component flows at any heater operating point could be directly read from mass-flow scales within the triangle area.

Equations, graphs and illustrative examples in the preceding articles were based on the assumption that all liquid components are admitted to the heater at temperatures less than heater-operating temperature, and that heat required to maintain proper heater temperature will be supplied from an independent source outside the heater.

In combined power generating and heating plants, such conditions may not always prevail, and at least one of the liquid component flows may be available at temperatures *higher* than heater-operating temperature.

A high-temperature liquid component introduced directly into the heat exchange process can be brought into the heater only in a flashing state. Because of steam liberated by flashing, a new source for heating steam is created inside the heater which will affect the flow rate of steam supplied from the outside source considerably.

A graphical treatment [2] for heaters with flashing liquid components can be carried out in the same way as for a heater with stable liquid components, although the method for obtaining the *Heater State Triangle* has to undergo certain revisions required by the new conditions.

In this concluding article, the typical heater with a total of three mass flows will be analyzed, where one of the liquid components enters in the flashing state. The adequate heat balance equation will be established and the new *Heater State Triangle* properly derived.

Heat Balance Equation

In setting up the heat balance equation, it should be remembered that the heat absorbing capacity of the cold component, makeup water for example, has to be entirely bal-

[1] Graph Your Deaerator Heat Balance, POWER ENGINEERING, December, 1951; and, Figuring Deaerator Flows, POWER ENGINEERING, August, 1952.

[2] It is obvious that construction of graphs as well as the readings are subject to certain observation errors, which cause any value obtained from the graphs to be only in close approximation to the correct value obtained by exact computation. Error limits inherent to this method do not exceed those of any other graphical method, and are considerably less than approved accuracy limits of any mechanical flow metering device. Figures shown in the graphs, representing solutions of examples, are computed.

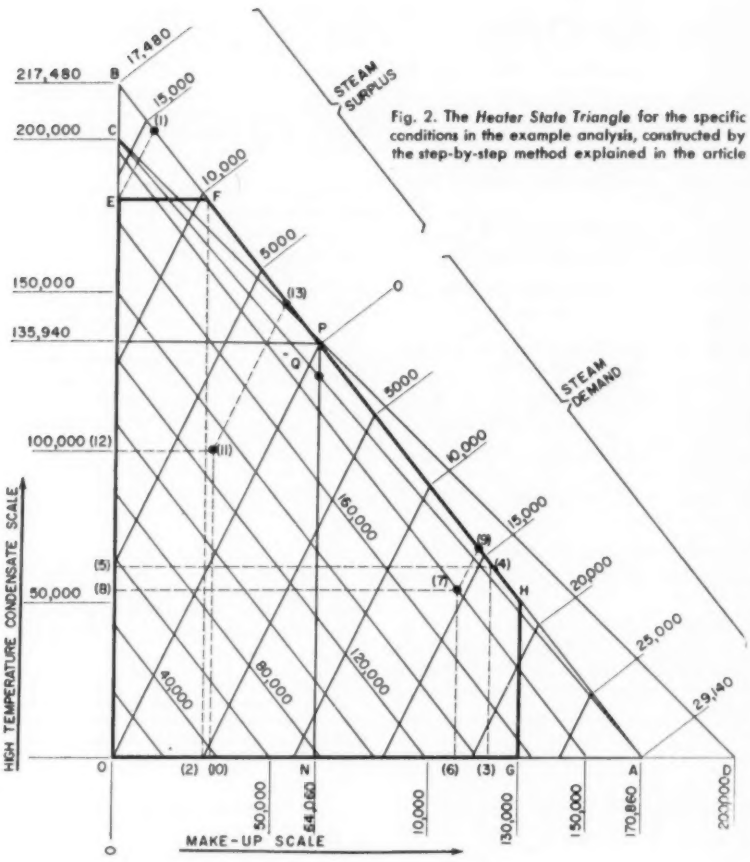


Fig. 2. The *Heater State Triangle* for the specific conditions in the example analysis, constructed by the step-by-step method explained in the article

anced against the aggregate heat release from both flashed and outside steam. Therefore, at rated capacity, when y per cent of high-temperature condensate with a flashing rate of f per cent has been brought into the heater, 1 lb of produced feedwater will consist of:

- x ..... per cent of makeup with a Btu per lb absorbed from the heating steam
- $(1-f)y$ .... per cent of water at heater temperature with zero Btu absorbed, and being liquid remainder of the high-temperature condensate after flashing
- fy ..... per cent of condensed flashed steam after release of c Btu per lb
- $1-x-y$ .. per cent of condensed heating steam from the outside source after release of c Btu per lb

Flashing rate of the high-temperature condensate is hereby defined as the enthalpy before and after flashing divided by the evaporation heat:

$$f = \frac{e_1 - e_2}{c} = \frac{\Delta e}{c} \qquad (1)$$

On the basis of these data the heat balance equation can now be written as:

$$ax = c(1 - x - y + fy) \qquad (2)$$

Rearranging equation (2), the basic heater equation now becomes:

$$\frac{x}{\frac{c}{a+c}} + \frac{y}{\frac{1}{1-f}} = 1 \qquad (3)$$

Equation (3) can be shown as a straight line in a rectangular coordinate system, as in Fig. 1. This line intersects the coordinate axes as points A and B, at the distances $\frac{c}{a+c}$ and $\frac{1}{1-f}$ from the origin, respectively.

What the Diagram Shows

The values $\frac{c}{a+c}$ and $\frac{a}{a+c}$, distances OA and AD, represent the maximum percentage of makeup water and correlated maximum percentages of steam required to develop rated capacity without participation of high-temperature condensate; and the values $\frac{1}{1-f}$ and $\frac{f}{1-f}$, distances OB and BC, represent the maximum percentage of high-temperature condensate and correlated maximum percentage of flashed steam to be relieved from the heater in order to develop rated capacity without participation of cold makeup.

After graduating the x-axis for makeup flow rates, and the y-axis for high-temperature condensate flow rates, and connecting the points C with D, and C with A, the following conclusions can be drawn from the diagram:

(1) The triangle OAC is the *Heater State Triangle* for heater operation with cold makeup and condensate at heater temperature with no flashed steam taken into account. This triangle, in conjunction with line CD, and because AD = AR, allows direct reading of the steam to be supplied from the outside source, related to any definite makeup flow rate. For a makeup flow of OI, for instance, a steam flow of MK would be required.

(2) The triangle OAB, being the desired *Heater State Triangle* for heater operation with makeup and the flashing liquid component, allows direct reading of correlated values of makeup and high-temperature condensate. The flow rate of flashed steam, related to any high-temperature condensate flow rate, is represented by the distance between lines AB and AC. A condensate flow EF, for instance, will release an amount of flashed steam shown by the distance HF.

(3) At rated capacity with a relatively small makeup flow, the amount of steam required to raise makeup water temperature will be smaller than the amount of steam available from flashing; hence flashed steam has to be relieved from the heater (HF > GH). At high flow rates of makeup water not only the total amount of flashed steam will be absorbed, but also a definite amount of steam has to be supplied from outside (LM < KM).

(4) Amount of steam to be supplied from outside is $1 - x - y$. This value is $1 - x - y > 0$, when steam has to be supplied from outside; and $1 - x - y < 0$, when flashed steam has to be relieved from the heater. If:

$$1 - x - y = 0 \qquad (4)$$

the amount of flashed steam available equals the amount of steam required by cold makeup, and no steam has to be supplied from outside. This condition is represented by point P at the intersection of lines AB and CD. Correlated flow rates for this point can be easily computed by solving equations (3) and (4) simultaneously. The values obtained are:

Makeup flow, $ON = \frac{cf}{a + cf} = \frac{\Delta e}{a + \Delta e}$

High-temperature condensate flow,

$$NP = \frac{a}{a + cf} = \frac{a}{a + \Delta e}$$

Flashed steam absorbed,

$$PQ = \frac{af}{a + cf} = \frac{af}{a + \Delta e}$$

The angle of the line OP with the x-axis is $\Theta = \arctan \frac{a}{\Delta e}$.

(5) At rated heater capacity for makeup flows decreasing from ON to zero, the surplus in flashed steam will gradually increase from zero to $\frac{f}{1-f}$;

and for makeup flows increasing from ON towards maximum, the steam to be supplied from outside will gradually increase from zero to $\frac{a}{a+c}$. Distances PB and PA can now be calibrated for increasing steam surplus, and for increasing outside steam, respectively.

(6) Steam scales will have different calibration units, except in the case where $\frac{f}{1-f} = \frac{a}{a+c}$. Then, $f = \frac{a}{2a+c}$, and the flow rates of makeup and high-temperature condensate will be $\frac{c}{2(a+c)}$, and $\frac{2a+c}{2(a+c)}$, respectively.

(7) The vertical distances between the lines AC and CP, and AC and PA, represent the amount of flashed steam participating in the heat exchange process.

(8) Reference lines for percentage of rated capacity can be found by calibrating the perpendicular distance from O to line AB; and reference lines for constant steam flow can be found by drawing lines parallel to OP through the calibrating points of the steam scales.

Example Analysis

In order to demonstrate the proper procedure for an actual application, analysis of a 200,000 lb per hr deaerator with makeup and high-temperature condensate admission will be given as an example.

The following data have been chosen as typical:

Heater capacity, K . . . 200,000 lb per hr
Makeup temperature . . . . . 60 F
Makeup enthalpy . . . . . 28.06 Btu per lb
High-temperature condensate . . . 300 F
Condensate enthalpy . . 269.6 Btu per lb
Heater operating temperature . . . 224 F
Enthalpy of water in the heater . . . . . 192.2 Btu per lb
Enthalpy of the heating steam . . . . . 1154.8 Btu per lb
Maximum makeup flow in lb per hr 130,000
Maximum condensate flow in lb per hr 180,000

The *Heater State Triangle* for these conditions is shown in Fig. 2, and it has been constructed by the following step-by-step method:

Step 1 Determine the flashing rate, the heat absorbing capacity of the cold makeup, and the heat release from the outside steam.

$$f = \frac{269.6 - 192.2}{962.2} = \frac{77.4}{962.2} = 0.0804$$

$a = 192.2 - 28.06 = 164.14$ Btu per lb,
$c = 1154.8 - 192.2 = 962.6$ Btu per lb,

Step 2 Compute the maximum percentages of makeup, outside steam, high-temperature condensate and flashed steam.

$$\frac{c}{a+c} = \frac{962.6}{1126.74} = 0.8543 \text{ lb per lb}$$

$$\frac{1}{1-f} = \frac{1}{1-0.0804} = 1.0874$$

$$\frac{a}{a+c} = 1 - 0.8543 = 0.1457 \text{ lb per lb}$$

$$\frac{f}{1-f} = 0.0874 \text{ lb per lb}$$

and the maximum flow rates for makeup, condensate, outside and flashed steam.

$$K\frac{c}{a+c} = 200{,}000 \times 0.8543 = 170{,}860 \text{ lb per hr,}$$

$$K\frac{a}{a+c} = 200{,}000 - 170{,}860 = 29{,}140 \text{ lb per hr,}$$

$$K\frac{1}{1-f} = 200{,}000 \times 1.0874 = 217{,}480 \text{ lb per hr,}$$

$$K\frac{f}{1-f} = 217{,}480 - 200{,}000 = 17{,}480 \text{ lb per hr}$$

and draw the lines OA, OB, BC and AD, and calibrate OA and OB for makeup and condensate, respectively.

Step 3 Draw the reference lines for fractional heater capacity parallel to AB.

Step 4 Compute the flow rates of makeup and condensate related to zero outside steam, and determine point P, the zero point for the steam scales.

$$ON = K\frac{\Delta e}{a+\Delta e} = 200{,}000 \times \frac{77.4}{164.14 + 77.4} = 200{,}000 \times 0.3203 = 64{,}060 \text{ lb per hr, and}$$

$$NP = K\frac{a}{a+\Delta e} = 200{,}000\,(1 - 0.3203) = 135{,}940 \text{ lb per hr}$$

(Note that at point P the amount, $fK\frac{a}{a+\Delta e} = 135{,}940 \times 0.0804 = 10{,}929$ lb per hr, of flashed steam will participate in the heat exchange — distance PQ.)

Step 5 Calibrate the distances PB and PA for steam surplus and steam demand, respectively; draw reference lines for constant steam flows parallel to OP; and draw lines EF and GH, corresponding to the specified flow limits of the liquid components.

The triangle drawn will yield solutions to all questions arising in heat balance computations, sizing of auxiliaries such as reducing valves, desuperheaters, relief valves, pipe lines, etc.

Problem Solutions

A number of problems have also been worked out for the assumed operating conditions, and the solution to each example has been properly explained.

Example 1 What are the capacity limits of the heater, related to a high-temperature condensate flow of 180,000 lb per hr?

Draw line E(1) and read from scales for steam and capacity for point E a *minimum* capacity of 165,528 lb of feedwater per hr, with 14,472 lb of steam per hr to be relieved from the heater.

Draw line F(2) and read from steam and makeup scale the *maximum* capacity of 200,000 lb of feedwater per hr when admitting 29,450 lb of makeup per hr and relieving 9,450 lb of steam per hr.

Example 2 Determine the steam and condensate flows required to develop rated capacity with a makeup flow of 120,000 lb per hr.

Draw lines (3) (4) and (4) (5) and read from scales: 15,263 lb of steam per hr and 64,737 lb of condensate per hr.

Example 3 Determine the steam and condensate flows required to develop a heater capacity of 180,000 lb of feedwater per hr, with a makeup flow of 110,000 lb per hr.

Draw lines (6) (7), (7) (8) and (7) (9) and read from scales: 14,282 lb of steam per hr and 55,718 lb of condensate per hr.

Example 4 Determine the output of the feedwater, when 30,000 lb of makeup water and 100,000 lb of condensate per hr are admitted to the heater.

Draw lines (10) (11), (11) (12) and (11) (13) and read from scales: net capacity of 127,078 lb of feedwater per hr, and 2,922 lb of steam per hr to be relieved from the heater.

Primary Objective

It has been the primary objective in using the example (Fig. 2) to magnify the effect of an unstable component by assuming exceedingly high values of its flashing and flow rate, and to disregard entirely any plant economy considerations.

The plant designer will, of course, always find other ways and other heat flow schemes for utilizing condensate at extremely high temperature; and he will admit to his deaerator heater only unstable components, which will have considerably lower flashing rates causing much lower losses in bleeding steam than losses computed in the example.

However, even in the case of low flashing rates, a careful investigation of the heater operating conditions must be carried out. Because of fading and even ceasing steam flow, operating points on the zero steam line must be thoroughly investigated, and the fact must be established whether the amount of flashing steam at these points will be sufficient to assure the necessary intensity of the deaerating action on the other component flows.

It is believed that familiarity with this graphical method as well as practice in working out examples, as presented here, will provide an additional useful tool to the engineer. In the hands of the plant designer or the operating engineer, this method can provide considerable help in performing any kind of checking work in a rapid and efficient manner.

Handle, Check, and Store Your Power Plant Lubricants Properly

By C. W. BELL, Sr.
Engineering Consultant

To get the best out of your power plant lubricants, provide clean, effective storage and dispensing facilities, keep good records, check lubricant performance to forestall bearing troubles

LUBRICANTS CONSUMED ..... COMPANY	DEPARTMENT (or section) ..... PLANT				MONTH 19					
EQUIPMENT UNIT AND DRIVE	TURB "A"	TURB "D"	ENGINE "B"	H.F.S. # 3	GREASE #3-LB	GREASE #5-LB	GREASE #6-LB	GREASE # 30	AIR COMP 30	RECL'D TURB.O-D
PULVERIZERS NOS. 1 AND 2	//			5Gal		//	𝍸 //			
STOKERS NOS. 1 AND 2	/	𝍸 /			𝍸		𝍸 𝍸 ////	10 qt		𝍸 𝍸 ///
AIR COMPRESSORS NOS. 3 AND 4			𝍸 /		/				𝍸 ///	
EXHAUST FAN NOS. 1 AND 2	////						///			
RAW COAL CONVEYORS NOS. 1 AND 2	///				𝍸 𝍸 //					
COAL ELEVATOR	/				𝍸 //					
TOTAL										

Fig. 1. Tally sheet of this type will help economize on oil, track down equipment defects

IN THE ARTICLE Plan Your Power Plant Lubrication With a Practical Approach, this writer discussed the first four requirements of a good lubrication plan:

1 — Plan for lubrication when buying equipment
2 — Buy lubricants from reliable sources
3 — Make use of best advice from both lubricant and equipment manufacturers
4 — Use charts to control everyday practice

In the present article let us look at three other vital factors in a good lubrication plan.

5 — Provide clean, effective storage and dispensing facilities
6 — Keep adequate, accurate records
7 — Follow up every indication of irregularity as a clue to threatening equipment failure

Storing and Dispensing

A clean, well ventilated room or rooms should be provided for storage of lubricants if possible.

Measuring dispensing devices with automatic counters should be given serious consideration.

The magnitude of organization and number of items, quantities and types of materials needed will ultimately dictate the elaborateness of the dispensing system.

Where the number of items and the quantities involved are small, the storage may even be in some open, general storage space, if insurance requirements and local regulations permit. If this plan is in effect, registering dispensers with locks are practically necessary.

If there are many items and the quantities large storekeepers may be available at all times and individual locking devices may not be necessary.

In all cases, the devices used and the precautions taken should be such that no free atmospheric dust or other contaminants are permitted to get into any lubricants. Dispensing must be under complete control at all times.

Reserve Supplies

Considerable attention should be given to quantities of each lubricant to be carried in stock and therefore to the size package of each grade to purchase. A given package (can, dispenser or drum) should be in such proportion to consumption rate as never to last over one year.

Where a firm supply, such as a bulk distribution plant of the contracting supplier, is nearby, this may be as low as a three-month minimum, provided the given item is always in stock there. A definite contract clause may be required to cover this protection.

In order to protect against operational delays due to large accidental losses of liquid lubricants from (for instance) important circulating systems, some authorities advocate a full batch in reserve. This supply, in some cases, may be in drums; in other cases, reserve tanks are set up.

If systems are very large, provision should be made for railroad car or tank truck deliveries. Generally, after the predetermined permanent system levels have been established, it is likely to be more practicable to purchase make-up as required in standard drums.

Records—Results

Once a stable lubrication schedule is established, a fair amount of attention should be given to details of handling and sufficient records should be kept to know where the oil goes.

In no case should effective lubrication be sacrificed for the saving of the last possible dollar on oil purchases; but — and this is important — a careful, effective record is quite sure to help economize on oil and will help track down equipment defects.

A tally sheet similar to Fig. 1 — "Lubricants Used" — can be developed.

Here are some examples to show how good records can help track down trouble.

A fan engine started requiring a great deal more oil than usual. A relatively small steam connection gasket leak was blowing it away.

A steam engine, of riding-cut-off, slide-valve type, showed signs of poor valve lubrication — it had a multipoint mechanical lubricator. This was speeded up, but to no avail. Examination showed poor distribution of lubrication on the steam valves. The one feed into the main steam line at the throttle was found blocked. Two lubricator units were connected to the steam line atomizer and some of the other points eliminated and the lubricator was slowed down. Fully satisfactory lubrications resulted, along with cutting the oil consumption to less than half.

Thrust bearing overheated on a high-pressure boiler feed pump; examination of the bearing showed damage. After refitting, it still ran hot. Internal inspection of the pump disclosed a seized impeller bushing ring.

Increasing damage in a turbine multicollar thrust bearing was caused by unbalanced loading, stemming from unequal turbine wheel clearances in the opposed elements of a double-flow steam path. "Oil wedge" scraping of all stationary rings proved sufficient here.

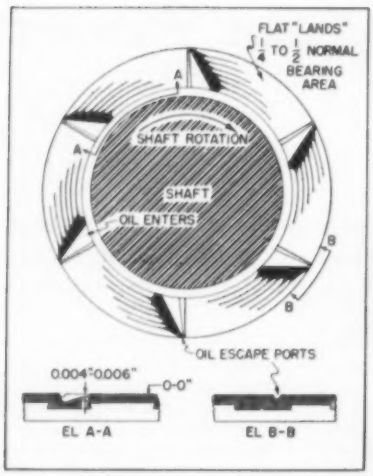


Fig. 2. This single-runner, after modification to oil wedge form as shown, gave several years service without rebabbitting. Before modification, it needed rebabbitting two or three times a year

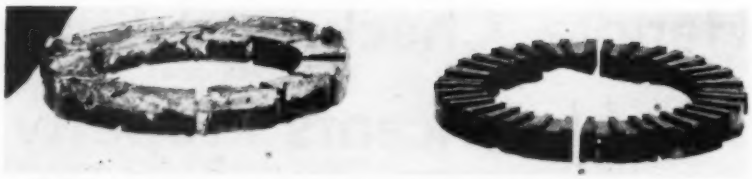


Fig. 3. Here is what happened to a heavy-duty steam turbine thrust bearing because of a freak interference to free expansion. At first, both bearing and oil were blamed until real cause was discovered

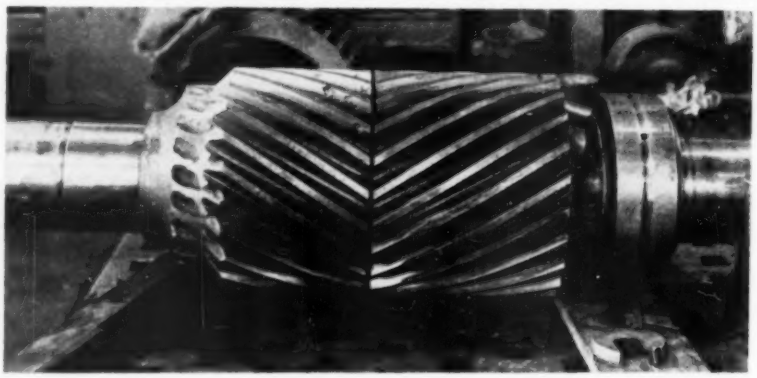


Fig. 4. Photograph above illustrates double herring-bone motor pinion which had been used in pulverizing mill. The damaged edge of the right-hand pinion was caused by misalignment and not by poor lubrication

An approximate fair axiom is that "Lubricants do not wear out — new oil is required to replace losses only." This thought applies mainly to conventional applications for liquid lubricants but it is good psychology as a basis for general thinking.

Any oil spatter or spillage from ring-oiled bearings is out-and-out waste, for it has practically no purging effect.

Where "once-through" lubrication is used, as with bottle oilers, mechanical or other constant feeds, a method of catching the discharge should be devised.

All oil level indicators on ring or wick-oiled bearings should only show levels between maximum and minimum permissible *operating* levels. The maximum must be set so there will be no overflow when unit is shut down.

Many oilers and other operators think their lubrication job calls for keeping every bearing full of oil regardless of waste.

On grease lubrication where pressure guns or cups are used, the grease is used as the vehicle to carry away dirt and spent grease. The rate of application should be such that new grease is not wasted. This applies both to hand application and to any automatic system — but should be just adequate to keep good lubricant effective at all times.

Condition of Equipment

Once a practical lubrication schedule is established, any apparent failure of lubricant should be investigated to be certain whether the lubricant or the equipment is at fault.

Lubricants can hardly be expected to overcome faulty alignment nor can oil get to working surfaces that do not have suitable approaches. The Kingsbury (sled runner) bearing demonstrated this long years ago; but some designers and shop-men continue to produce bearings that do not use their lubricant to good advantage.

In the old days of extremely low bearing pressures, some leeway was possible and fancy grooving could be tolerated. Newer equipment is usually built for higher unit bearing pressures and the maximum fraction of the loaded area should be kept available for actual carrying of load. (This is always less than the projected area in journal bearings.)

Some of the types of experiences the writer has had follow:

An adjustable multicollar thrust bearing on a centrifugal pump heated badly. Several types of oil had been tried and the bearing surfaces had been grooved. Bearing was refitted with freshly babbitted rings, suitable "oil wedge" scraping was done along with proper feed-in at multiple points. Relief flow from the working surfaces was controlled. A second round of scraping was done to bring all surfaces within load carrying range. From then on, the bearing ran so cool the operators worried!

A single-runner turbine thrust bearing that required rebabbitting 2 or 3 times per year was modified to "oil wedge" form with controlled relief flow. This resulted in several years service before rebabbitting. See Fig. 2.

A multiplicity of cases occurred where the side clearances on horizontal shaft bearings were insufficient, causing oil starvation in the load area. This was sometimes due to original fitting and in some to ordinary wear and too long a stretch between rescraping.

Misalignment, of course, causes many troubles which may seem at first to be failures of lubricant. Figure 4 shows a case of this kind for a heavily-loaded herringbone type gear.

It requires very detailed examination of parts, in many instances, to detect why operation is not satisfactory. This examination must be made during dismantling. Evidence is often destroyed during this process.

In failures of ball or roller bearings, it is often difficult to differentiate between cases caused by misalignment and those caused by inadequate lubrication. But it is a good plan to check for misalignment whenever such bearings fail. Another tendency of the "frictionless" bearings is to crack up, because of inaccurate adjustment which causes abnormal concentrations of load on rollers or balls. Misalignment in this case must be kept down to a half mil or less to give good service.

Research Is Answer to Buyer's Needs

SCIENTIFIC RESEARCH the key to tomorrow's industrial survival is the belief of Shirley A. Johnson, Director of the Denver Research Institute of the University of Denver.

Nowadays, new products are being invented at such a rapid rate that many industries must look to the research laboratory in order to keep abreast of the times and to avoid being forced out of business.

In today's highly competitive markets, a new invention can overnight wipe out public demand and need for a product in use for years.

The buying public is both fickle and well aware of its needs. When a new product comes along, supplanting an old one, demand for the latter often ceases at the wink of an eye.

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BY CARRYOVER

and BLOWDOWN?

Impure steam and excessive blowdown are two problems that need not be tolerated by any power plant engineer, thanks to effective anti-foam agents.

Within recent years, the Betz organization has developed several anti-foam agents which have produced remarkable results both from a standpoint of better boiler operation as well as direct savings.

For instance, a southern chemical plant installed a new high pressure boiler and turbine to operate in conjunction with the existing lower pressure boilers and turbines. To minimize silica vaporization, the condensate of all boilers was returned to the high pressure system. As a result, difficulties were encountered in the operation of the low pressure system—high boiler water solids developed causing severe carryover, and the low pressure turbines eroded seriously.

After analysis, Betz Engineers recommended the application of anti-foam agents which *immediately* remedied this carryover condition. The solids content of the steam was reduced to 2 ppm at high boiler ratings without any increase in blowdown.

The positive control of carryover and boiler blowdown is just *one* of the *many* services offered by the Betz Organization. Let a Betz Engineer explain to you how our *complete* engineering guidance can help you solve all your water problems. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

For the complete story on carryover and blowdown control through the use of anti-foam agents, write for Technical Paper No. 115.

BETZ

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How To Pick Most Economical Chimney Size

Relative cost of natural-draft chimney depends on volume of column. This depends on the HD value for any group of operating factors. Lowest HD—lowest cost. Here's how to get it. Author works it out for practical conditions in a table

By **J. G. MINGLE** Superintendent, Bureau of Air Pollution Prevention, City of Indianapolis

IN A PREVIOUS article, in the March 1952 issue, this writer discussed the factors to be considered in finding the proper size of natural draft chimney to produce required draft and deliver maximum quantity of flue gas passed to it for disposal. Curves of chimney performance were given, together with the necessary formulas for calculating required size, minimum diameter, and maximum height of a chimney. This calculation must take into account 14 factors affecting chimney size.

The question now arises: "Which size to select?" Ordinarily there is no condition as to a limiting diameter but the height may be limited by city air pollution control ordinances, proximity to adjacent buildings or air fields, air pollution possibilities in the neighborhood, and other factors. In general, however, the choice is usually determined by the cost of the structure, that size costing the least being the one chosen.

Relative cost of a chimney structure, regardless of the materials of which it is built, depends largely upon the volume of the shaft or column. A cost analysis may be made on the basis of either a cylindrical or a tapering form or shape. In either case, it can be developed that, in general, the volume of the structure and consequently the cost may be based on the factors HD (product of height and diameter expressed in feet) as a criterion and the value of the chimney-gas velocity which will result in the lowest value of HD for any group of operating factors will produce a chimney structure whose cost will be least and, consequently, will be the most economical size.

In arriving at the economical size, the problem involved consists of the derivation of an equation for the chimney-gas velocity which, when substituted in the equations for the required diameter and height, will give a combination of height and diameter whose product HD will be less than that of any other combination as determined by any other velocity. As shown graphically in Fig. 2, the value of the HD factors decreases as the chimney-gas velocity (V) increases until a certain minimum value of HD has been reached, after which the product HD increases. The problem involved, therefore, is one of maxima and minima.

Solution of the problem consists of deriving an expression for HD in terms of V and a series of constants, differentiating this expression with respect to V, equating the resulting group of factors to zero, and finally solving for V_e, the equation for the economical velocity. Substituting this equation in the equation for the required diameter gives equation (8) for the economical chimney diameter (D_e).

Also substituting the equation for the economical chimney-gas velocity in the equation for the required

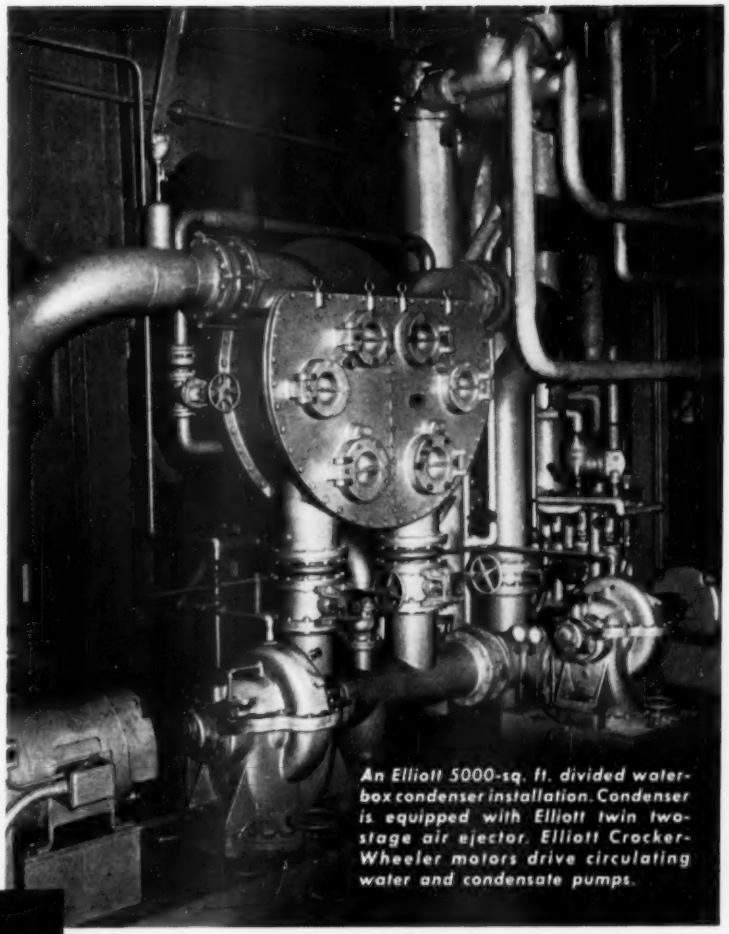
(*Continued on page 120*)

Table by Mingle showing economical chimney sizes for various flue gas temperatures and deliveries

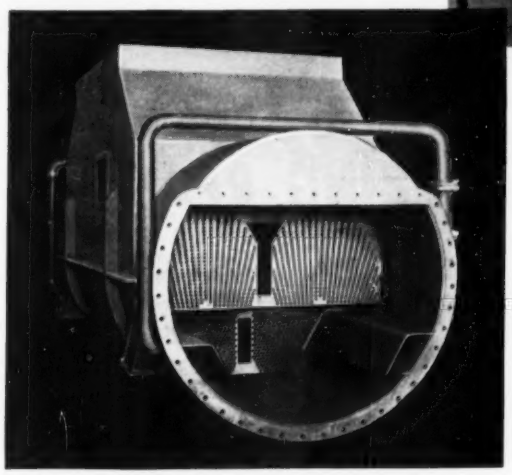
Based on atmospheric temperature of 68 F, chimney gas specific weight 0.0772 lb per cu ft, elevation 851 ft (29.0 in. H_g) above sea level, and friction coefficient of 0.018.

Chimney Delivery Lb Gases per Sec	Gas temperature 500 F		Total dynamic draft, In. H_2O	Economical Chimney Height, Feet, for Chimney gas temperature of		
	Economical Chimney Gas Velocity, Ft per Sec	Economical Chimney Diameter, Feet		400 F	500 F	600 F
5	17.94	2.90	0.25	58	49	44
10	21.13	3.83	0.30	69	59	52
15	22.86	4.50	0.35	81	69	61
20	24.19	5.05	0.40	92	79	70
25	25.25	5.54	0.45	104	88	79
30	26.31	5.96	0.50	116	98	87
35	27.11	6.34	0.55	127	108	96
40	27.78	6.67	0.60	139	118	105
45	28.31	7.01	0.65	150	128	114
50	29.11	7.30	0.70	162	137	122
55	29.64	7.59	0.75	173	147	131
60	30.17	7.85	0.80	185	157	140
65	30.70	8.11	0.85	197	167	149
70	30.97	8.35	0.90	208	177	157
75	31.50	8.58	0.95	220	186	166
80	31.90	8.81	1.00	231	196	175
85	32.29	9.02	1.05	243	206	184
90	32.69	9.24	1.10	254	216	192
95	33.09	9.44	1.15	266	226	201
100	33.49	9.64	1.20	277	236	210
110	34.02	10.00	1.25	289	245	219
120	34.69	10.37	1.30	301	255	227
130	35.29	10.70	1.35	312	265	236
140	35.75	11.02	1.40	324	275	245
150	36.15	11.33	1.45	335	285	254
175	37.34	12.05	1.50	347	294	262
200	38.41	12.72	1.55	358	304	271
225	39.34	13.33	1.60	370	314	280
250	40.14	13.90	1.65	381	324	289
275	40.80	14.45	1.70	393	334	297
300	41.60	14.95	1.75	405	349	306
325	42.26	15.44	1.80	416	353	315
350	42.93	15.90	1.85	428	363	324
375	43.46	16.34	1.90	439	373	332
400	43.99	16.77	1.95	451	383	341
			2.00	462	393	350

Elliott careful engineering builds better condensers



An Elliott 5000-sq. ft. divided water-box condenser installation. Condenser is equipped with Elliott twin two-stage air ejector. Elliott Crocker-Wheeler motors drive circulating water and condensate pumps.



This view of a 10,000-sq. ft. condenser with tube plate removed shows the fan type tube layout, partial tube supports, and air intake baffles.

THIRTY-FOUR YEARS of step-by-step development are back of the Elliott Type F Surface Condenser, and have resulted in a number of advances providing for better, more efficient operation. The most important of these results are:

1. *Maximum penetration of steam, with minimum pressure drop, due to improved tube layout.*
2. *Condensate temperature equal to steam temperature.*
3. *Minimum oxygen content of condensate.*
4. *Minimum terminal difference – the temperature difference between steam in the top of the condenser, and the discharge water.*

A further advantage in Elliott Type F condensers is the partial tube support design, in which support plates for the upper and lower tube banks are staggered rather than continuous, and thus do not divide the condenser chamber into cells, causing excessive pressure drop or dead spaces.

Type F condensers are built in sizes from 500 to 15,000 sq. ft., in both divided and undivided water-box type. They can be designed to meet specific space conditions. For details, contact your local Elliott engineer, or write Elliott Company, Jeannette, Pa.

ELLIOTT Company

CONDENSER DEPARTMENT

C3-1

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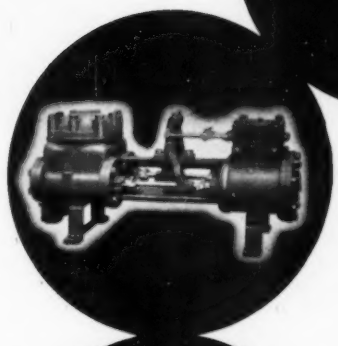
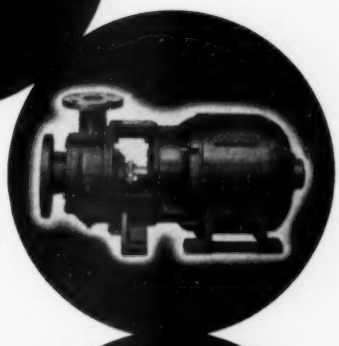
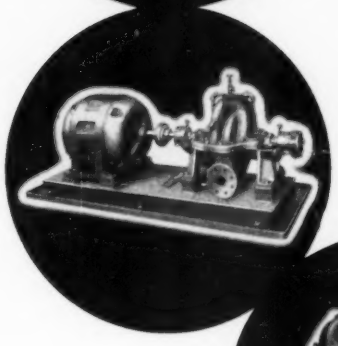
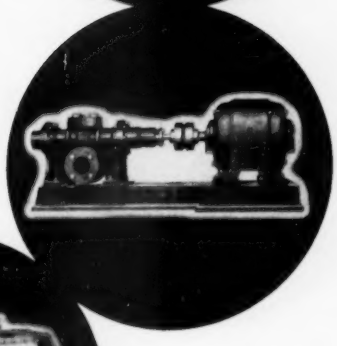
WARREN PUMPS

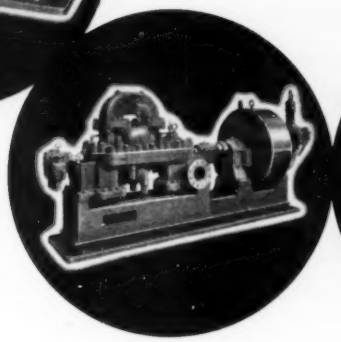


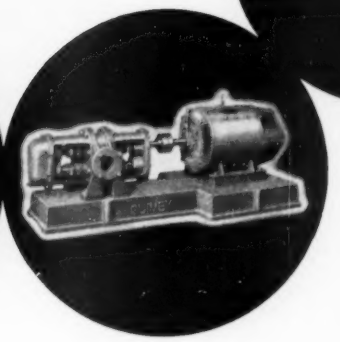


keep their heads!









. . . . . in other words, *maintained efficiency* has always been, and will continue to be, a fundamental virtue of all Warren Pumps. *Original* efficiencies in a pump can be very misleading and a source of disappointment in its long range efficient life expectancy.

The three most important factors affecting maintained efficiency are hydraulic design, leakage losses and friction losses. The generous acceptance of Warren Pumps for well over half a century is convincing evidence that Warren has the engineering ability, skilled pump mechanics, and plant facilities to handle all of these important factors to the definite advantage of their customers, from the angle of longe-range efficiency, minimum wear, and low power costs.

"THEY KEEP THEIR HEADS"

WARREN STEAM PUMP COMPANY, INC.
WARREN, MASSACHUSETTS

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Specify SCOVILL PHOSPHORIZED ADMIRALTY HEAT EXCHANGER TUBES

The "hot tip" that produces a winner in heat exchanger tube applications need not be just a lucky guess. With Scovill men and methods behind you, you can be in the money practically every time.

The fact is that Scovill Heat Exchanger Tube Technical Service is considered by many to be the most competent and experienced in its field. Scovill Phosphorized Admiralty Heat Exchanger Tube is also definitely out of the ordinary because it is hot-extruded from our Continuous-Cast Billets. Continuous Casting assures uniformity in chemical composition and optimum inhibitor (phosphorus) content . . . means a dependably better tube, especially for service with contaminated or brackish circulating water.

Because Scovill makes a wide range of the most popular Heat Exchanger tube alloys, we can be completely impartial in making recommendations for your particular applications. Inquiry outlining your problems is invited. A 40-page technical booklet will be sent on request. For complete information, contact: Scovill Manufacturing Company, 99 Mill Street, Waterbury 20, Conn. Phone Waterbury 4-1171.

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- NAVAL BRASS
- RED BRASS, 85%
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- COPPER NICKEL, 10% & 20%
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- CUPRO-NICKEL, 30% (High Iron)
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SCOVILL

"You can't buy better Brass"

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Could You Use SAVINGS *Like These?*

40% less
Fuel Consumption
50% more
Boiler Capacity

Bailey Meters and Controls Insure Savings at Kerr Bleaching & Finishing Works, Concord, N. C.

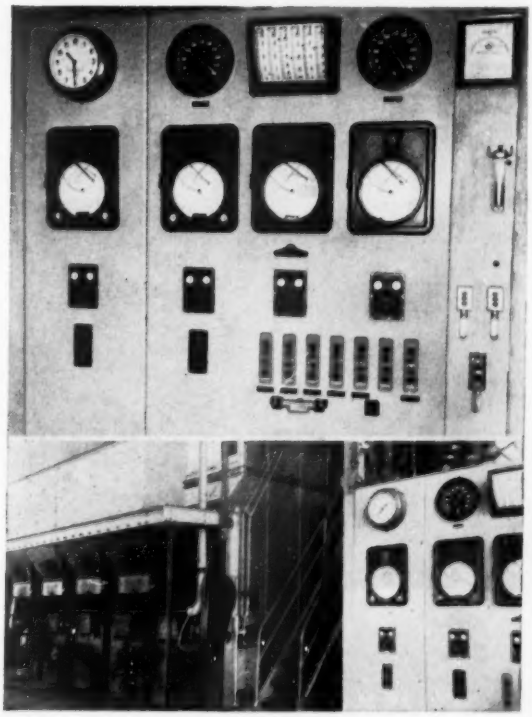
The key to complete returns on any investment in new power equipment is a fully co-ordinated system of meters and controls. It's the old story, the tail that wags the dog—careful attention to this comparatively minor part of the over-all installation cost can mean the difference between profit and loss in operation.

Here's where Kerr Bleaching & Finishing Works has cut operating costs—by installing *co-ordinated* Bailey Meters and Controls. The installation includes Bailey Meter Combustion Control, and Bailey Two-element Feed Water Control.

Such a co-ordinated system is an important plus for Bailey customers. Nowhere else can you buy such a complete range of equipment, selected without bias to do the best job for you. Nowhere else can you find such expert engineering service, immediately available through conveniently located direct sales and service representation. May we help you?

Call our local branch office or write for Bulletin 15-H.

A-113



Control panel, showing completely co-ordinated Bailey Meters and Controls at Kerr Bleaching and Finishing Works, Concord, N. C.

BAILEY METERS

BAILEY METER COMPANY

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CLEVELAND 10, OHIO

Controls for Steam Plants
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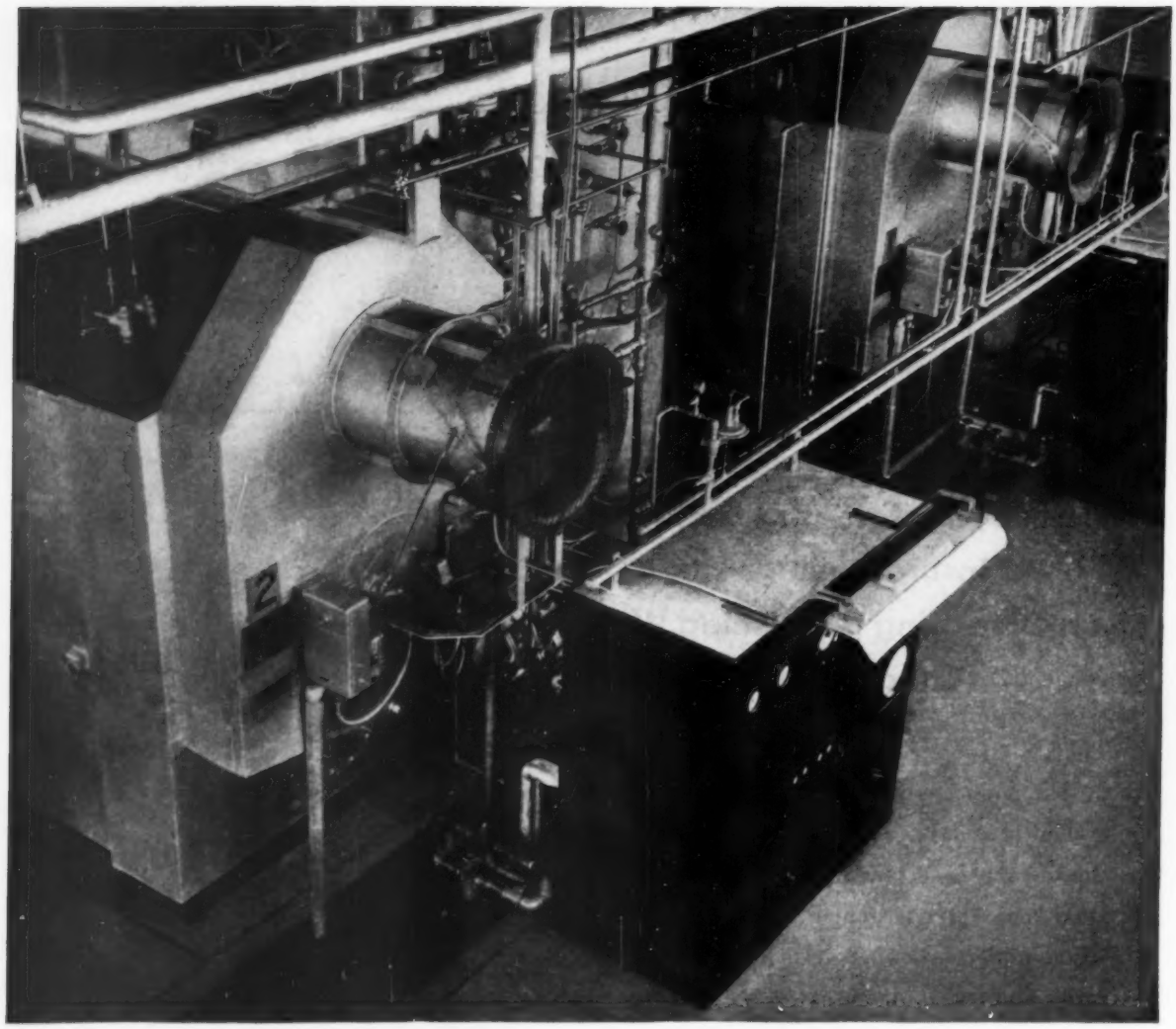

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- Saves Erection Time and Cost
- Meets Wide Range of Service
- Handles Quick Load Changes
- Fast Steaming
- Low Maintenance
- Easy Accessibility
- Suitable for Outdoor Service
- Burns Oil and/or Gas
- Saves Fuel
- Saves Space
- Safe, Automatic Operation

The shop-assembled B&W Integral-Furnace Boiler, Type FM, has gained industry-wide acceptance. Prominent companies in over 50 different industries, along with numerous utilities, educational institutions, hotels, hospitals, housing projects, office buildings, and government agencies have already selected this compact, self-contained steam generating unit for installations in 34 states, three U. S. territories and five foreign countries. Total steam capacity of units now in service and on order exceeds 5½ million pounds per hour. Nearly half of this capacity consists of multiple-unit applications of FM boilers instead of single larger-capacity units.

This recent B&W creation in low-cost steam generation is available in standardized sizes for loads of 2900 to 28,000 lb per hr at steam pressures to 250 psi.

Send for Bulletin G-76 describing and illustrating the many cost-saving features of this popular boiler. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd St., New York 17, N. Y.

BABCOCK & WILCOX

G-573

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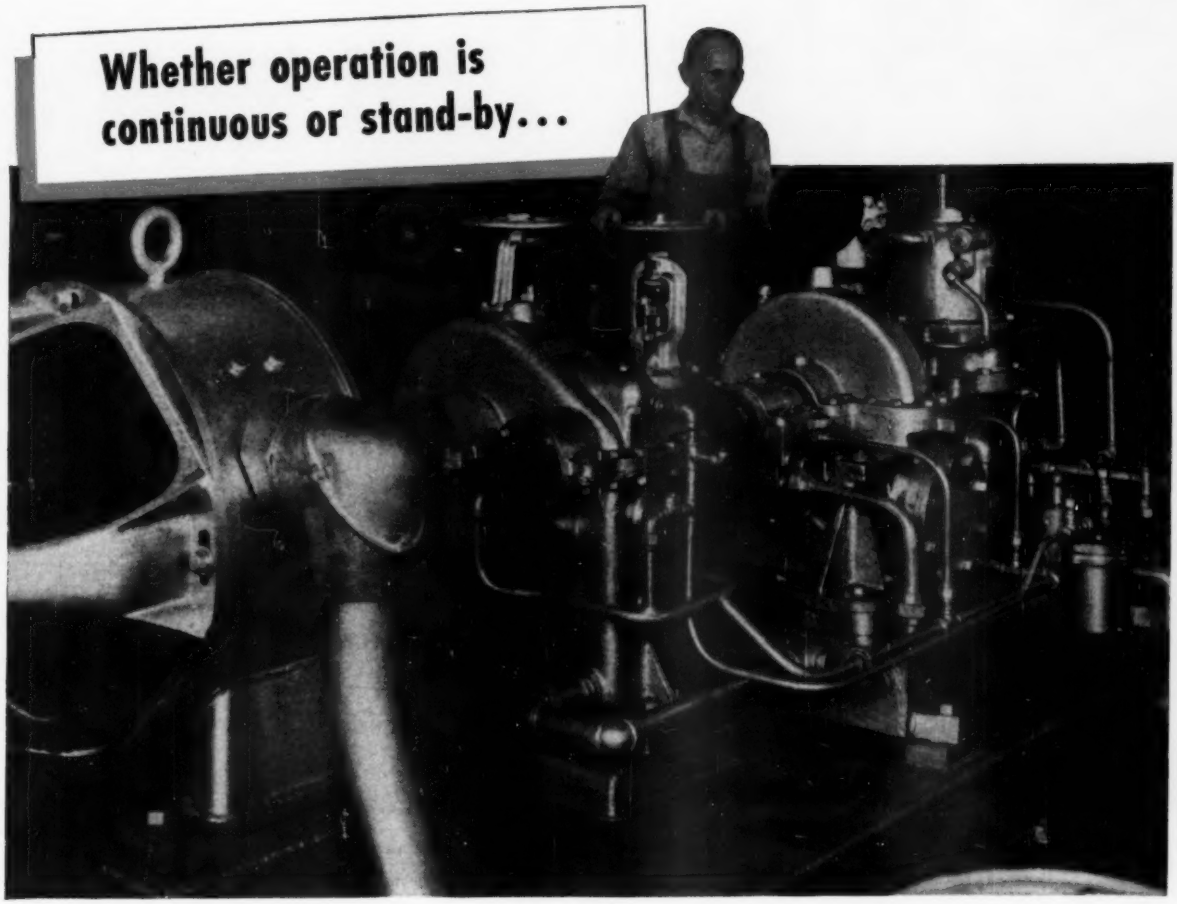

TYPE E turbines can handle it!

In the powerhouse of William F. Schrafft & Sons, makers of the famous "Schrafft's Chocolates," Charlestown, Massachusetts, the Type E turbine is used on a 40-kw, d-c exciter. The turbine exciter is supplementary to a motor-driven exciter for one 750- and two 1000-kw Westinghouse Turbine-Generators.

Of this installation, both the Chief Engineer and the Chief Power Plant Operating Engineer stated, "We are impressed by the design, appearance, and smooth-running qualities of the Type E turbine, and also the unique design of the oil-relay governor and forced-feed lubrication which the Type E provides." This all-Westinghouse end of Schrafft's power plant includes a new 1000-kw Westinghouse Geared Turbine-Generator, served by existing Westinghouse switchboard equipment and motor-generator sets.

Here's the general-purpose turbine that meets the many stern demands of modern industry. Regardless of operating conditions, the Type E is built to give dependable, trouble-free, economical performance for long periods of continuous operation . . . or instant operation when used as a stand-by drive.

Other types in the complete Westinghouse general-purpose turbine line include heavy-duty and multi-stage units for applications requiring higher temperatures and pressures, higher speeds, greater horsepower, extraction for process applications or higher efficiency than can be obtained with single-stage machines. Get the facts on this broad turbine line . . . call your nearby Westinghouse Office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50540

YOU CAN BE SURE...IF IT'S
Westinghouse
TYPE E Turbines

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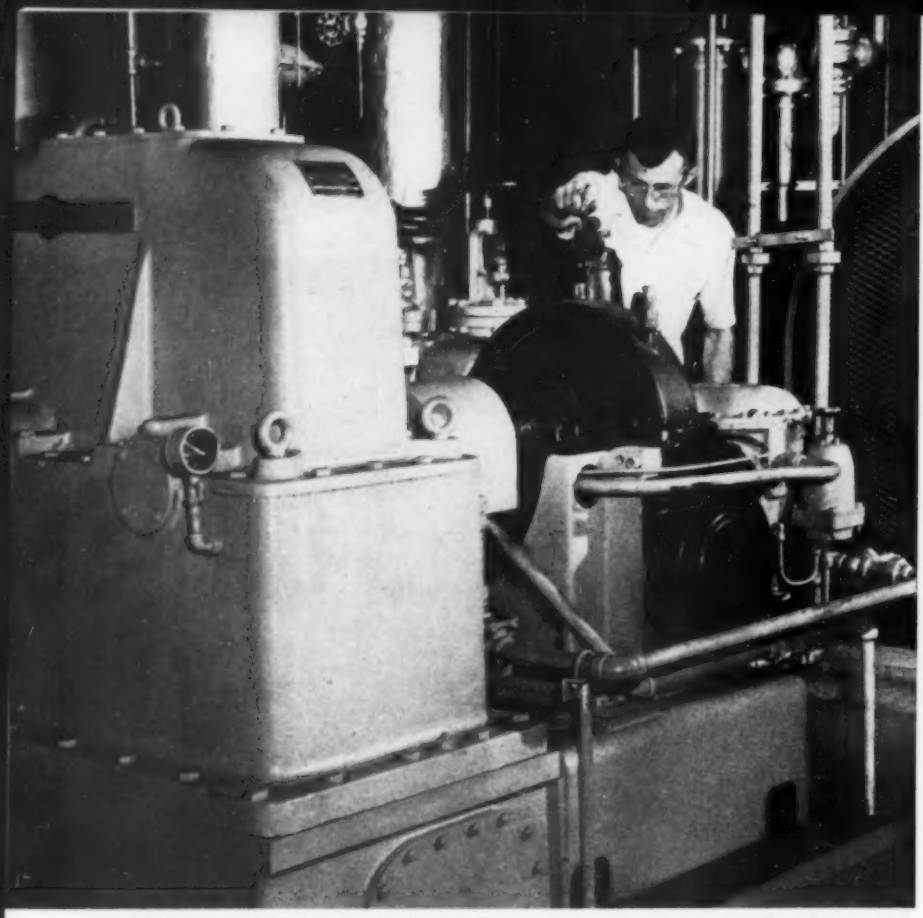
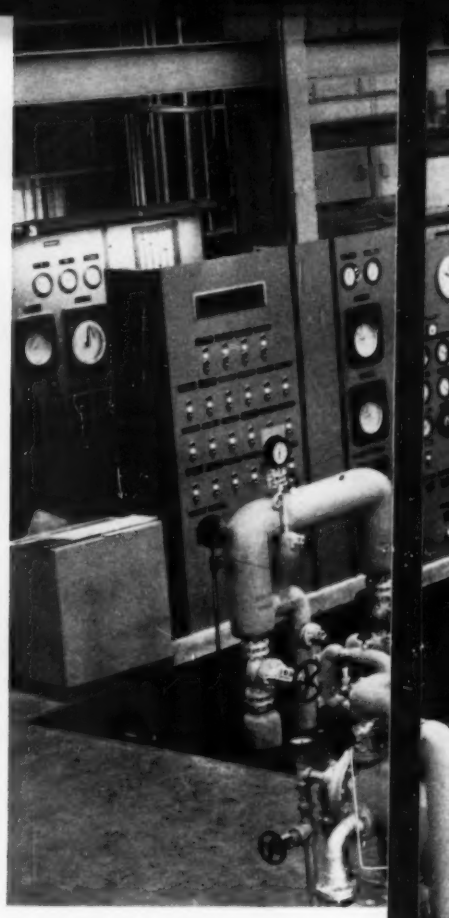
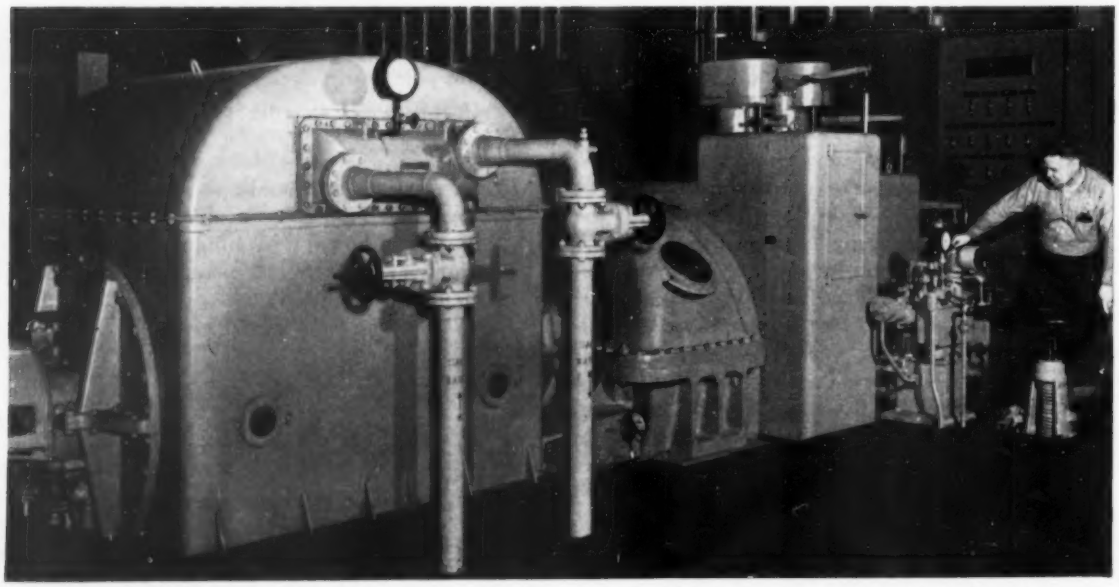


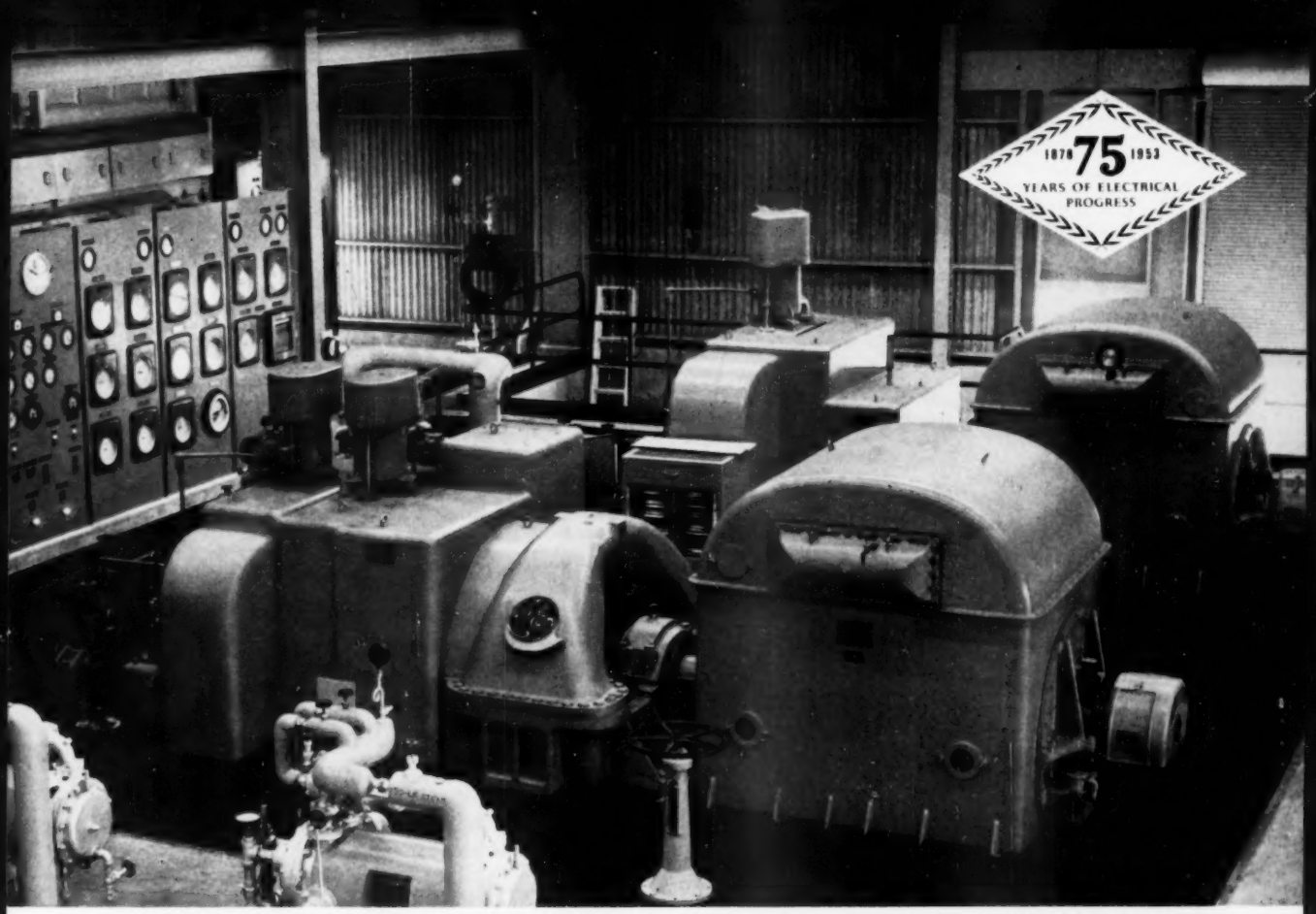


G-E TYPE DP MECHANICAL-DRIVE TURBINE, rated 135 hp, drives standby air compressors. J. A. Chamberlain, Supervisor of Utilities at Barber Refinery, checks turbine.

G-E Turbines Maintain Plant Steam



EASY STARTING of the General Electric 2000 KW double extraction turbine-generator at California's Refinery is demonstrated by W. E. Riley, Station Operator. Handwheel initiates small pilot valve, requires almost no muscle effort to operate.



DOUBLE-EXTRACTION CONDENSING TURBINE-GENERATOR in foreground supplies process steam at 150 psig and 15 psig for refinery operations at "California's" Barber, New Jersey plant. Other turbine is straight condensing.

Balance at "Calso's" Barber, N.J. Refinery

2000 KW Turbine-generators Reduce Boiler Steam to Process Pressures; Mechanical-drive Turbine with High-speed Precision Gear Drives Utility Air Compressor.

To make fullest use of available high-pressure steam, to obtain economical by-product power, and to automatically maintain plant steam balance over a wide range of steam flows, the California Refining Division of The California Oil Company selected two General Electric turbine-generators for its Number Two plant at the Barber, N. J. Refinery.

Extraction steam from one turbine-generator, a 2000 KW unit, is delivered at 150 psig and 15 psig for various process uses. Turbine governing accuracy is such that even when extraction steam or electrical load requirements vary, extraction pressures are held constant. A second 2000 KW unit exhausts to a condenser.

The "California" Refinery also installed a General Electric Type DP mechanical-drive turbine with a G-E high-speed precision gear to drive one of the compressors which furnishes utility air for use throughout the refinery. In an emergency, this turbine-driven compressor could meet complete compressed air demands.

If your plant uses process steam, why not take advantage of G.E.'s experienced turbine engineering resources. G-E engineers will study and recommend ways for you to best utilize steam supply. Get more for your turbine dollar with G-E turbine-generators. General Electric, Schenectady 5, N. Y.

256-5

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GENERAL ELECTRIC

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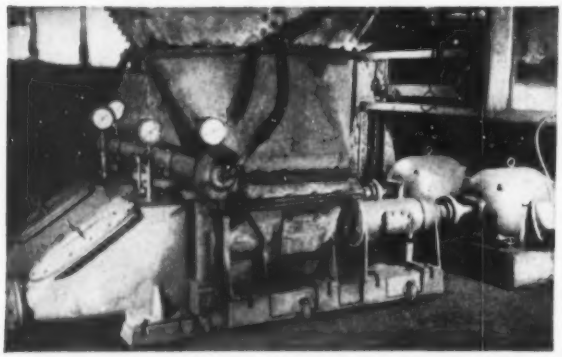
Asphalt filler dust
Barytes
Bauxite
Catalysts
Cement (Portland)
Cement raw Materials
Chalk
Clays (dried)
Coal (pulverized)
Coke Dust
Dolomite (pulverized)
Feldspar
Flue Dust
Fly Ash
Fuller's Earth
Gypsum (calcined)
Gypsum (raw)
Lime
Limestone (pulverized)
Magnesite
Manganese dioxide
Ores (pulverized)
Phosphate rock (pulverized)
Rock dust
Soda ash
Starch



Quick, dust-free handling of pulverized coal, using Fuller-Kinyon System.

Check and

PASS ON

Make this a memorandum — and Pass On to others — if your processes require mass handling of dry, pulverized materials.

Check the materials which you handle and *Pass On* this information to the Fuller Company.

With twenty-six years of experience in this specific field, the Fuller Company can help engineer your handling methods into less costly, more efficient, more dependable operation.

THE FULLER-KINYON SYSTEM FOR DRY PULVERIZED MATERIALS CONVEYING HAS SEVERAL DISTINCT BENEFITS:

1. Mechanical movement limited to few parts.
2. Little to get out of order.
3. No explosion or occupational hazards.
4. Pipelines carry material vertically, horizontally, around corners — between multiple operations.
5. Fuller-Kinyon Pumps maintain full capacity over long travel distances, at low cost.
6. Portable units perform several operations.

Pass on the word to Fuller for specialized engineering assistance on any problem involving mass handling of dry, pulverized materials. Fuller's twenty-six years of such experience is yours to command. Send along a memorandum to Fuller now.

DRY MATERIAL CONVEYING SYSTEMS AND COOLERS · COMPRESSORS AND VACUUM PUMPS · FEEDERS AND ASSOCIATED EQUIPMENT

Fuller

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1631

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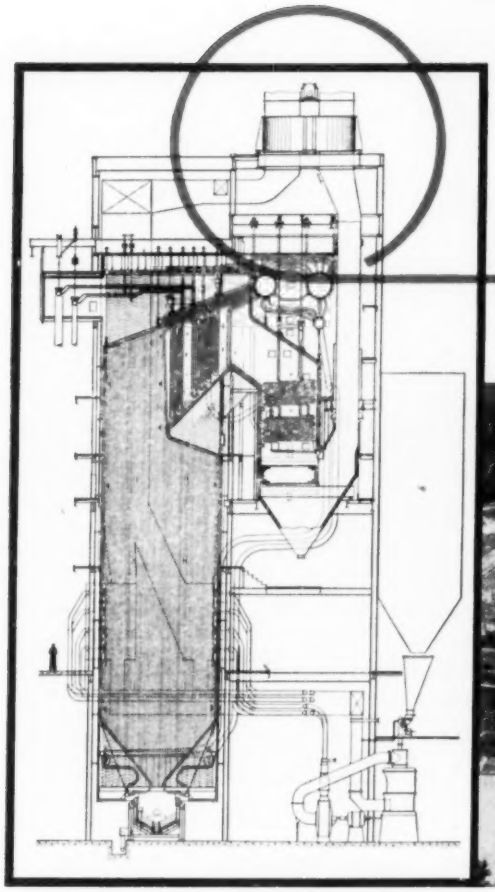
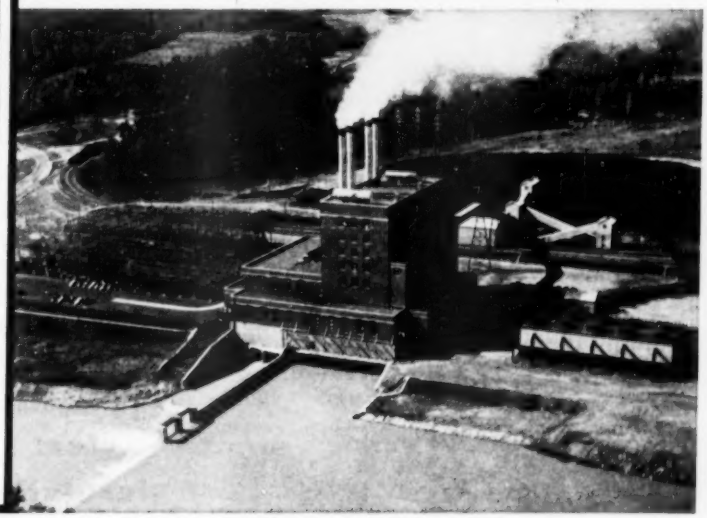
All Reheat Boilers at New Lee Station of the Duke Power Company

equipped with

LJUNGSTROM AIR PREHEATERS





By mid-summer last year, both units of the first section of the Duke Power Company's new Lee Station had gone into service. Designed and built by Duke Power's own organization, Lee Station's 190,000 kilowatts help fill the growing power needs of industrialized South Carolina..

Each of the station's two 90,000/100,000-kw turbine-generators is powered by a boiler designed and built by Combustion Engineering—Superheater, Inc. These C-E Steam Generating Units are fired by pulverized coal, and furnish steam at a throttle pressure of 1250 psi and 950 F, reheated to 950 F.

Two Ljungstrom Air Preheaters are used with each boiler. These Ljungstroms preheat combustion air to 620 F and cool exit gases to 310 F.

Lee Station is another example of the unanimity with which the Ljungstrom Air Preheater is accepted as a standard unit for high-efficiency steam generators. Since the war, Ljungstrom Air Preheaters have been specified for an hourly capacity of over 285,000,000 pounds of steam.

THE Air Preheater Corporation 60 East 42nd St., New York 17, N. Y.

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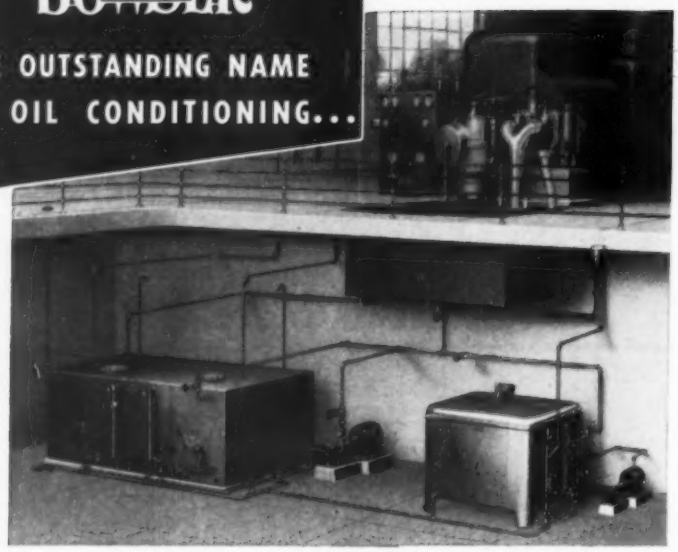
THE OUTSTANDING NAME IN OIL CONDITIONING...



...for power generating equipment!

This Bowser turbine oil conditioning system keeps oil "bone dry" and crystal-clear . . . the best "stay-on-the-job" insurance a turbine bearing can have. Costly bearing failures are avoided and less stand-by equipment is required with Bowser oil conditioners. Turbine oil lasts for years, too! That's why Bowser oil conditioners are on the job in a majority of power plants.

...for insulating oils!

The Bowser Hydro-Volifier is a conditioning unit for transformer, circuit breaker and switch oils. It restores oil dielectric to 35 k.v. in a single pass while the equipment remains energized . . . no service interruptions with Bowser oil conditioning!

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(Continued from page 108)

height gives equation (9) for the economical chimney height (H_e).

$$D_r = D_e = \frac{0.287 \left(\frac{W_g}{B_a} - \frac{T_c}{w_c}\right)^{2/5}}{\left[\frac{T_c \left(\frac{w_a}{T_a} - \frac{w_c}{T_c}\right)}{f w_g}\right]^{1/5}} \quad (8)$$

$$H_r = H_e = \frac{0.353\, D_{\text{db}}}{B_a \left(\frac{w_a}{T_a} - \frac{w_c}{T_c}\right)} \quad (9)$$

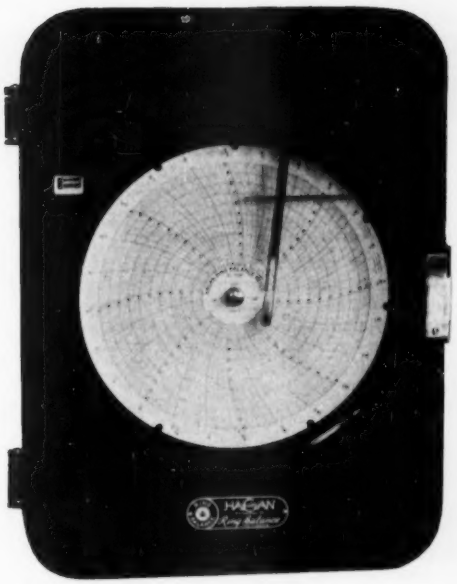
In the typical example, the value for the economical chimney-gas velocity is 34.4 ft per sec, the economical diameter 10.22 ft, and the economical height 237.5 ft.

It should be noted that the 238 ft 0 in. by 10 ft 3 in. size of chimney is the most economical size of structure from the standpoint of cost. There are also many other sizes, as many in fact as there are velocities to be assumed, that will satisfy all the requirements of the typical example. Each size will produce 1.21 in. w g of available draft to overcome the 1.21 in. w g of total dynamic draft when delivering 116 lb of gases per sec.

If, for example, due to proximity of the plant to an airfield the height of the chimney is limited to about 200 ft 0 in., the corresponding diameter will be 13 ft 6 in. If, on the other hand, air pollution control requirements demand a height of at least 260 ft 0 in., the corresponding diameter will be 9 ft 6 in. To carry on to an extreme example, the corresponding diameter of a chimney built in connection with a 600 ft office building in a metropolitan district will be 7 ft 0 in. Since none of these latter sizes come within the range of the economical size, they are obviously more costly structures than the most economical size of 238 ft 0 in. x 10 ft 3 in.

In evaluating the various factors for substitution in the equations, keen judgment should be exercised with all items in which there are variations. The average chimney gas temperature should be the temperature of the gases at normal operation taken at the breeching entrance to the chimney. An erroneously selected high chimney-gas temperature will result in a stack too short for proper operation at lower temperatures. Chimney-gas temperatures are of great importance in determining chimney sizes for smelters, waste-heat installations, oil refineries, etc. The mean atmospheric temperature of 68 F is selected as a standard reference temperature for standard conditions. The barometric pressure factor should correspond with the elevation above sea level at which the plant is built. A friction factor of 0.018 should probably be taken on faith but this value results in draft intensities that correspond with observed intensities. The numerical value for the quantity of gases to be delivered or handled should be the

When you install



HAGAN RING BALANCE FLOW METERS

You install

Accuracy

Dependability

Durability

Versatility

BOILER COMBUSTION CONTROL SYSTEMS
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CONTROL SYSTEMS FOR AUTOMOTIVE AND
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Hagan Ring Balance Flow Meters give dependable readings over the chart range, and give good response at low flow rates.

The calibration may be checked under full static pressure conditions by a simple check-weight method. One man can check calibration in a few minutes.

The simplicity of design, coupled with sturdy construction, assure long meter life and low maintenance costs.

The Hagan Ring Balance Meter is the most versatile meter made. Whatever your metering problems, our engineers will be glad to show you how Hagan Meters can help you solve them.

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Tips on TESTING . . .

. . . ELECTRICAL INSULATION RESISTANCE

Reconditioning Wet Apparatus

The bad effects of excessive moisture in insulating material, particularly when localized, are numerous. The effect most likely to result in failure in the early stages of exposure is that of low resistance paths which may develop either through or over the surface of the insulation. The likelihood of failure from this cause is increased by the presence of dirt and other foreign matter, and may occur in either organic or inorganic insulating material.

If moisture has been deposited on clean insulation only superficially, then the heat resulting from the normal operating temperature of the equipment may remove it before failure occurs. However, the normal operating heat of at least some parts of the equipment is sometimes insufficient to drive out moisture that has penetrated through surface defects.

If moisture is allowed to remain in insulation, it usually—in time—causes corrosion of metal conducting parts, aggravated by the presence of chemicals and electric potential, thus increasing the danger of failure.

In addition to apparatus which may be exposed to moist atmosphere, or wet with fresh water, there may be occasions when it becomes necessary to rehabilitate equipment that has been subjected to salt water. In such case, clean fresh water must be used to remove all traces of salt before drying of the apparatus is attempted. Any evidence of oil or grease on the insulation should also be removed by using a volatile solvent such as carbon tetrachloride.

Then the apparatus must be dried out before electrical potential is applied. Numerous methods and various temperatures for drying out electrical equipment are used, including forced hot air, ovens, circulating electric current through the conductors, or combinations of these methods. Local conditions and facilities, manufacturer's recommendations, and the type of equipment involved, dictate the method used.

Test Procedure

If possible, secure records of previous insulation resistance tests on the apparatus.

Make short-time tests and time-resistance tests for comparison to help decide whether drying is necessary. If present readings are at all comparable with previous tests made at or corrected to the same temperature, a drying-out run *may* not be necessary.

NOTE: *The above material is taken from our Instruction Manual—for the use of Megger Insulation Testers. Within its 96 pages, such subjects as "Temperature Correction", "Interpretation" and many others are discussed in a clear and interesting manner with very ample illustrations, charts and tables. We'll be glad to send you a copy of this manual without obligation. Just write on your company letterhead for* ***Manual 21-J-PE.***

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THE DR. HORN TACHOMETER

We offer you immediate delivery of this instrument, considered by many to be the ultimate in a fine speed measuring device. Pointer affords instantaneous reading of rpm of rotating shafts, or linear and peripheral speeds, regardless of direction of rotation. Measures in six ranges from 25 rpm to 30,000 rpm. Protected against overspeeding damage. Operates equally well in a vertical, horizontal, or slanting position. Simple mechanism. Low maintenance. Long life.

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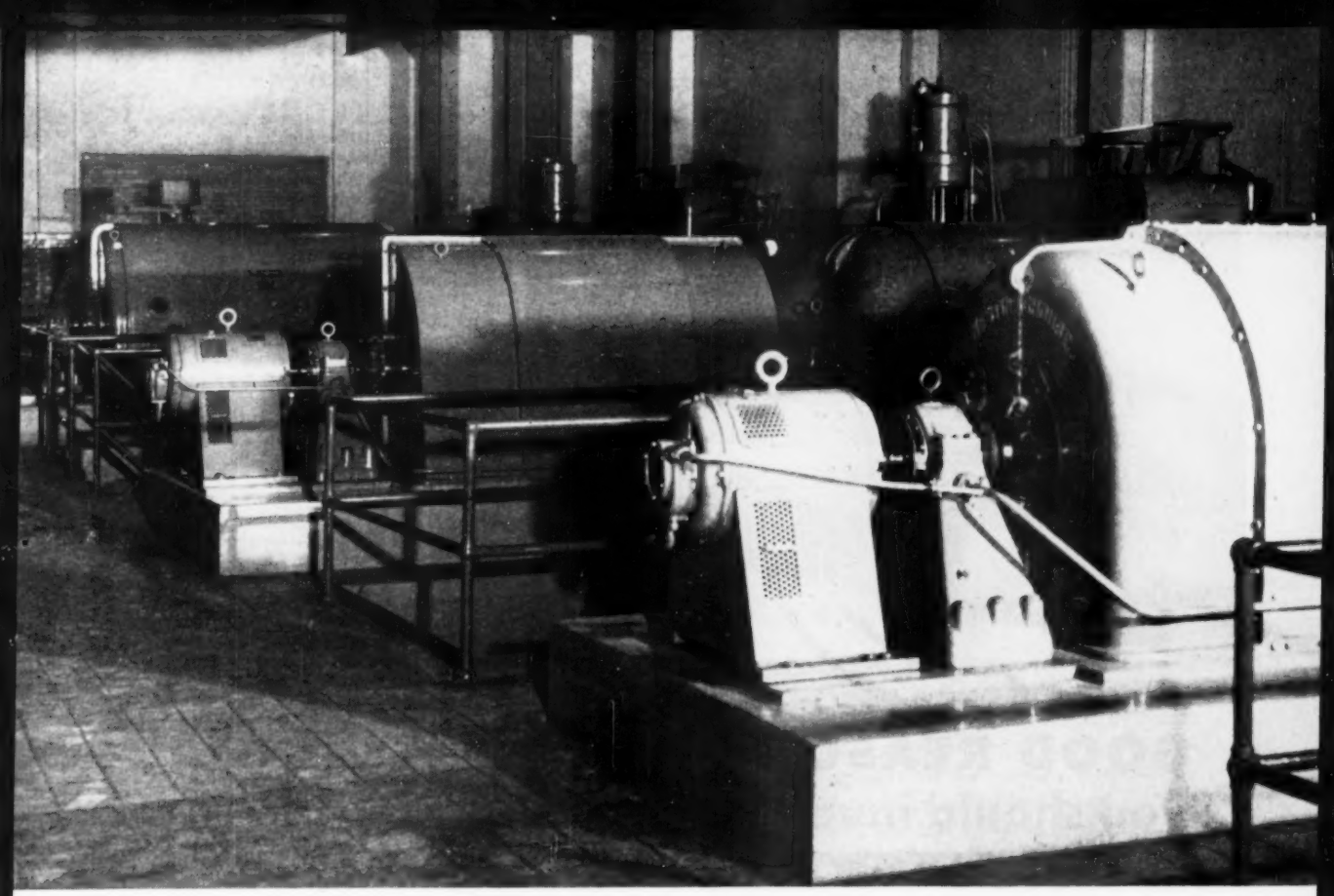
maximum under any consideration of operation. For example, in the typical example, the stack will *not* deliver 116 lb of gases per sec against a total dynamic draft of 1.21 in. w g if the chimney was designed for a delivery of only 100 lb per sec. The chief point to remember in the selection of these numerical values is that, with one exception, the stack will not perform properly at lower values when higher values should have been selected.

Table of Chimney Sizes

The subject of Table of Chimney Sizes has been a moot question for years and has been repeatedly discussed in articles by this writer and others. Such tables are of great assistance in the ready and easy selection of a required size of chimney but they may lead to a totally improper size for the required operating conditions of the plant. One table in particular based on boiler horsepowers has been commonly used for years. With all due respect to the author of that table, its construction is based on improper and insufficient assumptions. It is no more possible to select the required size of a natural draft chimney based only on boiler horsepower with no consideration of the total dynamic draft requirements than it is possible to select the proper size centrifugal pump, for example, on the basis of the capacity requirements only and with no attention being taken of the total dynamic head against which the pump is to operate, or for an induced- or forced-draft fan based only on the quantity of air or gases to be handled.

Much of the smoke emitted from chimneys can be traced to improperly selected chimney sizes. In most cases the chimney is of insufficient height but the improper size may also involve too small an area, or a badly proportioned structure. No mean portion of the business of many chimney construction companies includes the extending or "heightening" of existing natural-draft chimneys to gain more draft.

It is possible to construct a table of chimney sizes for general uses based on average operating conditions but any size selected from it should be checked by numerical calculations from the equations given heretofore. Since the size of a chimney is influenced by the factors previously enumerated, they should be taken into consideration in determining the proper size of a new chimney. Their inclusion in a composite table, however, would result in a very difficult affair to read. However, by assigning values for the chimney-gas temperature, the chimney-gas specific weight, the atmospheric temperature, the barometric pressure corresponding to altitude of the plant, and the friction coefficient, simple equations in which only the quantity of gases to be delivered and the total dynamic draft appear as variables can be formulated.



Turbine oil with a past . . . and future

• The story of NONPAREIL Turbine Oil in the Water and Light Commission plant, Fairmont, Minnesota, is one of a long successful past and a guaranteed trouble-free future. It's a typical story of the kind of performance offered by NONPAREIL Turbine Oil.

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TRADE MARK
Turbine Oil

In 1929, NONPAREIL got its start in this plant by solving a sludge problem in a 1500-KW unit. Water could not be separated from the conventional lubricant previously used, and sludge had resulted. Good separation was obtained with NONPAREIL, and sludge troubles were eliminated.

As other units were installed, they were filled with NONPAREIL—a 2500-KW unit in 1938, a 4,000-KW unit in 1945, a 4,000-KW unit in 1949.

None of the original fills of oil has ever been removed from the four turbines, either for reconditioning of the oil or for cleaning of the lubrication systems. Neutralization numbers of the oil fills have remained below 0.09 mg. KOH/gm. There have been no failures or troubles of any kind caused by faulty lubrication.

That's the past of NONPAREIL Turbine Oil in this plant—23 years of trouble-free, cost-free lubrication. What's more, the same effective lubrication is assured for the life of these turbines. Each fill of NONPAREIL is guaranteed by Standard Oil to last for the life of the turbine it lubricates and to maintain a neutralization number below 0.15 mg. KOH/gm.

A Standard Oil lubrication specialist will be glad to show you lubrication records of NONPAREIL in installations similar to your own. In the Midwest, you can contact him by phoning your local Standard Oil office. Or write: Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY **STANDARD** *(Indiana)*

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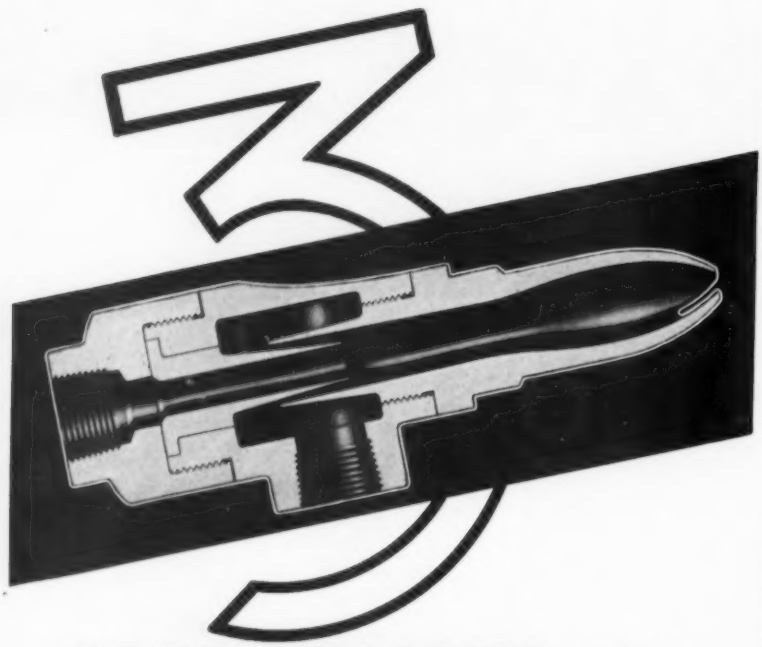

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Write for Bulletin 21

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

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On this basis, assuming a chimney-gas temperature of 500 F, a chimney-gas specific weight of 0.0772 lb per cu ft under standard conditions, an atmospheric temperature of 68 F, an atmospheric pressure of 29.0 in. Hg corresponding to an elevation of 851 ft above sea level, and a friction coefficient of 0.018 for sooted surfaces, and substituting these values in equation (8) for the economical chimney diameter, we get equation (10).

$$D_e = 1.527\ W_g^{3/8} \qquad (10)$$

Also making the proper substitutions in equation (9) for the economical chimney height results in equation (11).

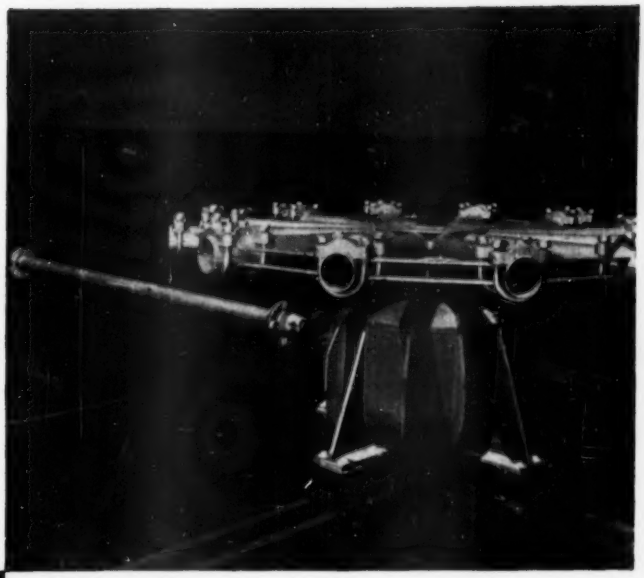
$$H_e = 196.31\ D_{tdh} \qquad (11)$$

Table II gives the economical chimney-gas velocity and the economical chimney diameter for a chimney-gas temperature of 500 F, based on the above assumptions. The chimney-gas temperature has but little effect on the economical chimney diameter within a fairly wide range of temperatures. The table also gives the economical chimney height for chimney-gas temperatures of 400 F, 500 F, and 600 F, based on the same assumed operating conditions. Note that the chimney-gas temperature has a very appreciable effect on the economical chimney height. Thus, for the operating conditions noted in the typical example, the economical chimney size as selected from the table (by interpolation) is 10.22 ft in diameter for a delivery of 116 lb of gases per sec and 238 ft in height for a chimney-gas temperature of 500 F and a total dynamic draft of 1.21 in. w g. For a delivery of 45 lb of gases per sec, the economical diameter would be 7.0 ft and for a total dynamic draft requirement of 1.0 in w g the economical height would be 196 ft for a chimney-gas temperature of 500 F or 175 ft for 600 F.

This table of economical chimney sizes should be employed only for the assumed operating factors noted. Where the latter differ appreciably from the actual conditions, the size should be determined from equation (8) for the economical diameter and equation (9) for the economical height. The table, however, may be used for average operating conditions of the average-sized plant and also for checking results obtained from calculations.

How, it now may be asked, can properly sized chimneys contribute to smoke control? The answer is obvious: a proper area or diameter will allow it to deliver the gases passed on to it for disposal and a proper or sufficient height will enable the chimney to create the available draft necessary to overcome the total dynamic draft at the maximum delivery. Unfortunately, chimneys cannot be equipped with superchargers (except possibly by induced-draft fans) and they must act by themselves with the energy supplied in the gases.

MARLEY Mechanical Equipment is POWERED for PERFORMANCE



Driving the large fans of modern cooling towers is a rugged job . . . one that demands power transmission equipment designed with an extra measure of sturdiness. With its added strength it must also be precision built for long, smooth service. That's why Marley designs and manufactures every element of the mechanical equipment for Marley cooling towers. The result is specialized equipment for a specific service.

MARLEY GEAREDUCER*

An exclusive Marley design utilizing hardened alloy steel gears, tapered roller bearings and heavy, carefully machined shafts—all in an extra strong, well sealed, cast iron case. Lubrication to every point is constant and flow is maintained whether operation is forward or reverse.

MARLEY TWINFLEX* DRIVE SHAFT

This accurately balanced assembly is constructed of heavy steel tubing zinc-coated and sealed against internal corrosion by welded flanges. It transmits power to the cast steel yoke through pre-moulded neoprene inserts bonded to cadmium plated steel cores. They have excess load capacity that easily absorbs starting shock and transmits power smoothly.

MARLEY FAN HUB

This hub for largest fans is of all-steel construction. Hub spokes are seamless steel tube; center hub and clamps are steel castings. It is precision welded throughout for great strength. After fabrication, the hub is hot dip galvanized. The design provides quick adjustment for fan pitch and uses a retention pin for added safety.

Any Cooling Tower May Be Modernized with Marley Mechanical Equipment

The Marley Company

Kansas City, Missouri

MARLEY

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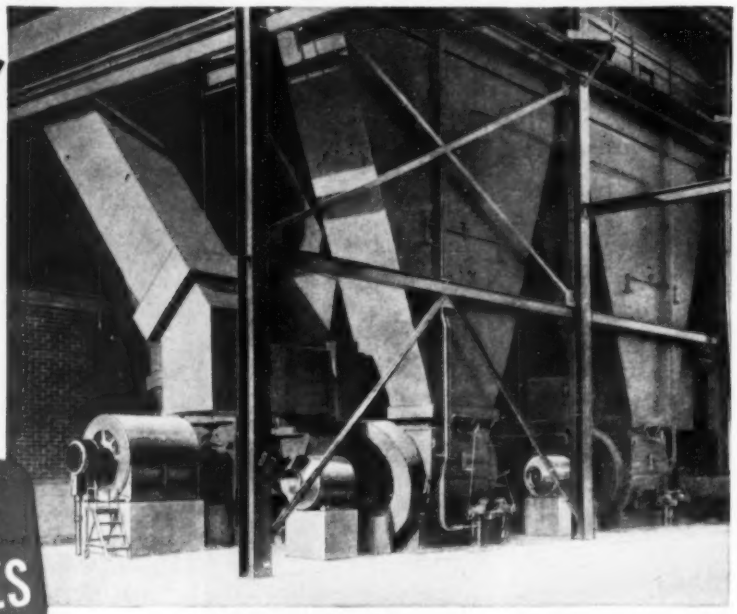
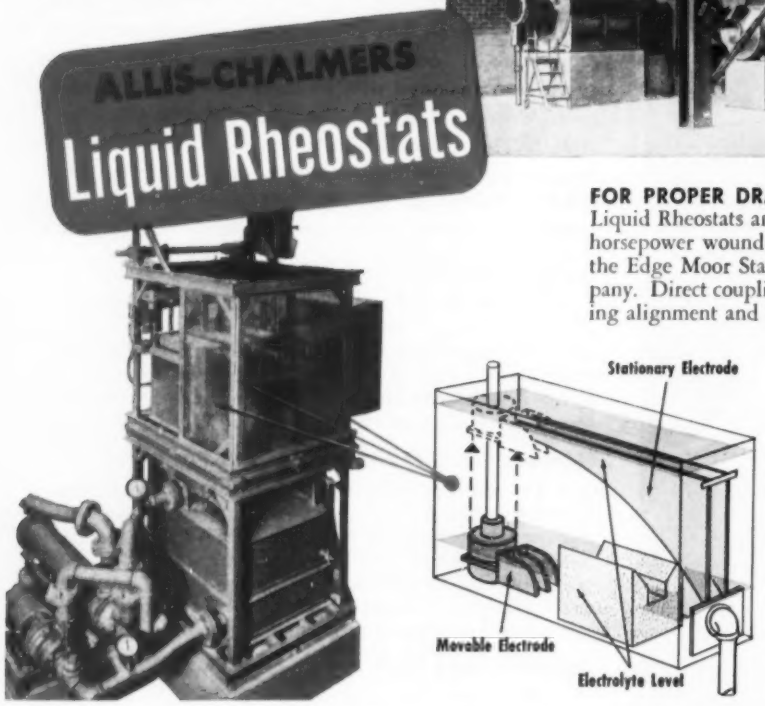
STEPLESS SPEED CONTROL

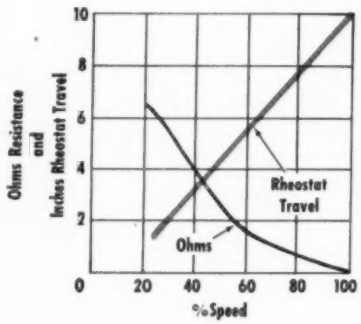
Engineered

for boiler draft fans



FOR PROPER DRAFT CONTROL of boilers, Allis-Chalmers Liquid Rheostats are used in the secondary circuits of four 600 horsepower wound-rotor motors driving induced draft fans at the Edge Moor Station of the Delaware Power & Light Company. Direct coupling of fans and drive motors simplifies bearing alignment and maintenance problems.





TYPE 257 LIQUID RHEOSTATS can be placed in any convenient spot because only electrical connections are required. In this case, they are on the lowest floor of the power plant; the tube type TEFC drive motors are outdoors.

RHEOSTAT CELLS have both a movable electrode and a variable electrolyte level. The movable electrode is always completely immersed. Hot spots are eliminated by directing the flow of cooled electrolyte through the electrode plates.

STRAIGHT LINE SPEED CHARACTERISTICS are designed into these rheostats for each application. Needed resistance characteristics are built in by shaping the stationary electrode, and by fixing distance between electrodes.

ALLIS-CHALMERS

Allis-Chalmers Liquid Rheostats have but few moving parts . . . no arcing contacts. Electrodes can be actuated by electric, pneumatic, or hydraulic operators. Call your A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin for leaflet 14S7544.

A-3721

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Wood Waste Power

(*Continued from page 75*)

been more practical, particularly if the surplus power could be sold to a utility.

Favorable Results

Results of the installations described have been very gratifying as illustrated in the curves, Figs. 6 and 7. Figure 6 was prepared to show the relative net gain in pounds of steam generated between the old and new installations. The curve labeled *old* is the record of the hrt-boiler installation which was manually fired. A net gain of 186,000 lb of steam per day was achieved on a basis of 40,000 fbm of lumber cut. These are tabulated results over a period of one year.

Figure 7 was prepared to show the relative net gain in kwh generated between the old and new installations. A net gain of 145,500 kwh was achieved on the same basis of 40,000 fbm of lumber cut.

As a matter of interest it might be noted that at the rate of 1 cent per kwh, power for a productive rate of 40,000 fbm would cost $2,740 per month, or $32,880 yearly. A single engine or turbine generator complete with related equipment and housing could be paid for in a surprisingly short time.

It can be seen that wood waste can be an asset, if the engineering of the plant is economically sound and progressive.

DuPont Lowers Investment

(*Continued from page 79*)

structure. Extent of shelter must be dictated by economic considerations. Manufacturers have been making tremendous strides on this problem and soon such outdoor installations with no protection may well become commonplace.

Our power investment is affected by the close tie-in required between power and process facilities where interchange of fuels and other materials occurs. A close tie-in has many obvious advantages, and also some less concrete ones. Familiarity with operating process and equipment permits the power engineer to specify materials of construction or equipment. The power engineer can call to the process engineer's attention opportunities for savings and thus reduce investment by conserving and utilizing steam at temperatures and pressures most readily available. Unnecessary peaking of utility loads can be analyzed in terms of process variables, and often reductions in such excessive power demands are impressive. Finally, the power designer is placed in constant competition with those whose viewpoint is different and can maintain flexibility to take advantage of developments in other fields of engineering activity.

Net result should be continual lowering of power investment.

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CORROSION PROTECTION for your STEAM SYSTEM

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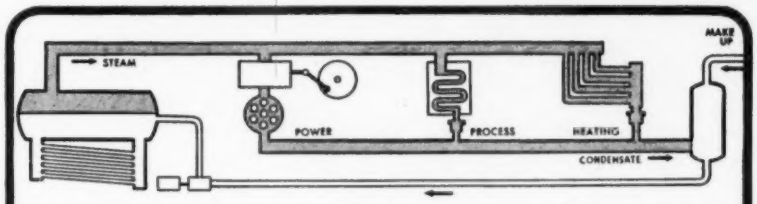

The CORAVOL ZONE—indicated by the shaded area in the diagram—includes every part of a steam system not accessible to boiler feed water treatment. It includes the boiler above the water line, steam lines, condensate return lines, radiators, valves, traps and equipment. This zone can now be reached and protected against rust and corrosive action—by CORAVOL.

CORAVOL IS PART OF A COMPLETE TECHNICAL SERVICE which provides special chemical formulas for . . . boiler feed water . . . foam prevention . . . hot water supply . . . refrigerating brine . . . cooling and condenser water . . . rapid scale removal . . . coagulation . . . algae control . . . fuel oil supply . . . soot removal.

CORAVOL circulating throughout your steam system protects it from corrosive attack. **CORAVOL** saves costly pipe repairs and replacements—maintenance labor—hours and days of shutdown loss. **CORAVOL** cleans out clogging rust deposits, improving heat transfer, restoring original capacity of lines and efficiency of valves and traps.

CORAVOL, the original* amine process, has the flexibility that lets it conform to each individual need. The **CORAVOL** you will use is formulated to do the best protective job under your own plant conditions.

*The use of **CORAVOL** in steam systems is covered by U. S. Patent No. 2053024. The Western Chemical Co., owner of this patent, grants licenses under which volatile AMINES purchased from other sources may be used in steam systems upon payment of royalty to Western Chemical Co.

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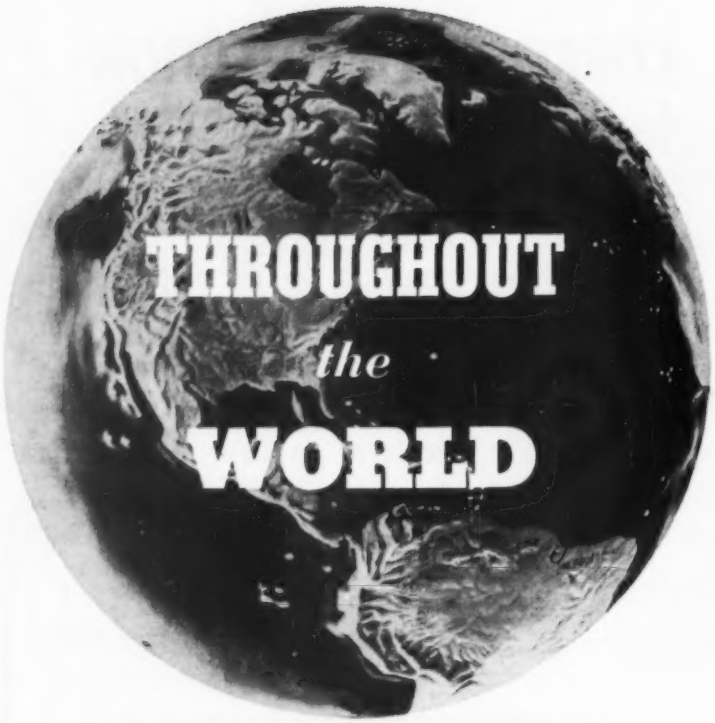

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Radial Engine Power

(*Continued from page 81*)

mind that to the cost of a steam station must be added the cost of conversion equipment including about 15 per cent spares at a cost of $60 per installed kilowatt. One great advantage of gas engines over steam equipment is that the gas engine units are small enough so that the spare capacity may usually be of the order of 10 or 15 per cent. With large steam units, it is often necessary, in order to obtain any reasonable economy, to use units so large that the spare capacity must be of the order of 33 to 50 per cent. If we assume, therefore, that the cost of the two stations is the same per installed kilowatt, extra spare capacity for the steam station makes installed cost for a steam station considerably greater.

Operating Costs

To determine the operating costs of this proposed plant, we will approximate our fuel costs at 10 cents per 1000 cu ft of gas (1000 Btu per cu ft lhv). Based on recent operation of the engines at the Alcoa plant, we have a fuel consumption rate of 10,500 Btu per kwh, including the parasitic load mentioned before. This efficiency is in the neighborhood of the best and largest high pressure steam plants. Records likewise indicate that lubricating oil can be purchased in tank car lots for about 40 cents per gal with lube oil consumption figured at 3000 kwh per gal. Maintenance material and parts for major overhaul has been figured at $1.50 per installed horsepower per year. This has been termed liberal by Alcoa and we therefore assume it to be adequate. Miscellaneous cost for plant supplies is pro-rated on the basis of $50 per engine per year, which is again somewhat higher than experience indicates.

A good yardstick was needed to properly determine labor costs, both operating and maintenance, and Table III is based on the operating personnel found adequate by Alcoa at Point Comfort. This table of labor costs lists personnel required for one, two and three potlines. It is significant to note that the cost per kilowatt-hour decreases as additional lines are added. This is true since the addition of another line does not in every case double the personnel required for the original potline.

Table IV shows our estimated direct operating cost to be 1.75 mills per kilowatt-hour for a 3 potline plant. Charges for amortization, interest on investment, insurance and taxes would, of course, vary according to the type of accounting procedure used and is not included in the above figure.

Following the above cost data, the paper included a discussion of maintenance of these radial engines. This will be presented in a future issue.

An Outstanding Record of Acceptance!

LESLIE Floatless Level Control installation on five 85-90000 kw generators, maintaining the hotwell level ±1" by controlling 6" valve in condensate pump discharge—in service 12 months—led to 16 more installations for same company.

The above is typical of the fast growing acceptance of this rugged and accurate level control.

ADVANTAGES

- EASY TO INSTALL
- ACCURATE REGULATION (±1" Water Column)
- NO FLOATS, STUFFING BOXES, ETC.
- MULTI-MEDIUM ACTUATED
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- ACTION REVERSIBLE

Applications: On open and pressurized vessels, including boilers, tanks, evaporators, heaters, standpipes, etc.

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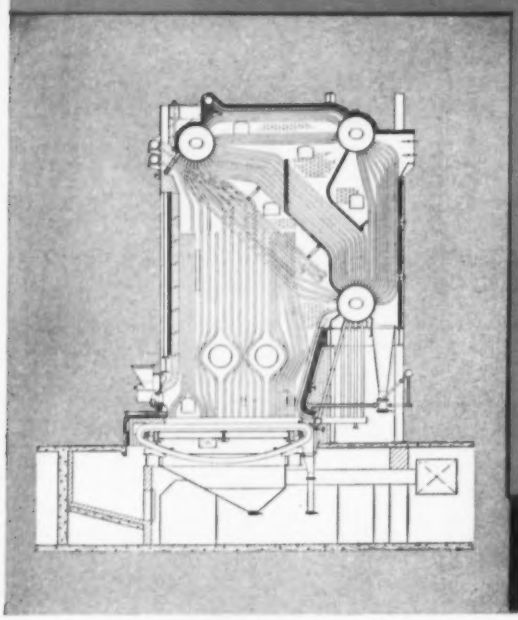
CITY OF FAIRMONT, MINNESOTA



BOILER DATA

2—E.C. 3-drum—80,000 lbs./hr.—750°F (TT)—399 lbs. O.P.—425 lbs. D.P.—water cooled side and rear walls—Erie City "Travagrate" Spreader Stoker with 12,000 B.t.u. Illinois coal and gas firing.

An Outstanding Record of Performance

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1943—All Electric and Steam Heat Rates Reduced
1945—All Electric Rates Reduced
1949—Increased costs forced 10% increase in all rates

The City of Fairmont, Minnesota, population 10,000, operates its own light, power, water and low pressure commercial steam heating services. The power plant, rebuilt in 1920, houses one 40,000 and one 60,000 pound boiler and two 80,000 pound per hour Erie City 3-drum steam generators added in the past five years. Its kwh generated has increased from 1.8 to 34.6 million in 1951.

The late G. E. Basom, had devoted 28 years to the careful management of this utility. Its outstanding record of rate reduction over the years is a monument to his devotion to the public trust. It is also a matter of great pride to this community that not one cent of taxes was required for financing their utility.

We are proud to have Erie City "Travagrate" Spreader fired Erie City 3-drum steam generators serving the City of Fairmont.

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HELPFUL BULLETINS

(*Continued from page 88*)

tions. Containing catalog data and ordering information as well as application photos, explains how cords are made, where used, advantages. Koiled Kords, Inc.

BOILERS, GENERATORS

127 Packaged Steam Generators — Bulletin 525, 12 pp, describes packaged generators designed to give full steam pressure within 2 min from a cold start. Discusses features of the generator, stresses advantages for stationary boiler plants and for process steam and other applications. Fully illustrated, includes engineering specifications for standard units from 18 to 450 hp. Vapor Heating Corp.

128 Steam Boiler Units — Eight-pp Bulletin 508 describes complete boiler units designed for oil or gas or combination firing. Discusses the important features of these factory built units and some 17 installations are pictured. Johnston Brothers, Inc.

COAL HANDLING

129 To Stop Coal Dust — Bulletin 952 describes company's Zipper bunker seal, showing how it works to keep dust from flying from belt conveyor traveling tripper discharge spouts feeding bunkers. Stresses dust tightness, quiet operation, safety and automatic operation of the seal, explains how it provides a positive dust control system for coal bunkers. Stephens-Adamson Mfg. Co.

130 Automatic Coal Scale — Sixteen-pp Bulletin 0352 introduces a new automatic coal scale for weighing coal as it is fed to boilers, enabling a power engineer to maintain a constant check on boiler efficiency. Book gives construction and operating details on the belt feeder, weigh hopper, scale housing, operating levers and accessories. Photos and line drawings show scale features and a large engineering drawing gives dimensions of 15- and 40-ton-per-hour models. Richardson Scale Co.

OTHER EQUIPMENT

131 Air-Cooled Heat Exchangers — Technical Bulletin R-53-DC1 is a 6-pp illustrated article on the economics of the air-cooled heat exchanger for process cooling. Discusses air-cooled exchangers and their selection, gives design details that affect cost and evaluates operating costs. The Marley Co.

132 Diesel Engine Primer — This informative, pocket-size 28-pp booklet is written in non-technical language and shows how simple it is to understand the operation of the modern diesel engine. Titled, "What You Should Know about Diesel Engines," it records the diesel's invention and early development; compares it with the gasoline engine; tells about two-cycle and four-cycle types, and reports recent design. P & H Diesel Div., Harnischfeger Corp.

133 Proportional Mixers — Of special interest to engineers concerned with gas fired industrial furnaces, ovens, kilns, driers is 12-pp Catalog 805A. Describes simultaneous controlling and proportioning of air and gas with a single control valve for manual or automatic operation. Mixer capacity tables are given for five kinds of gases, and for eight pressure ratings. Hauck Mfg. Co.

134 Electrical Precipitators — Now available is the third edition of company's 42-pp booklet on Cottrell electrical precipitators. Illustrated, covers wet and dry types of precipitators, their functional parts, sources of high voltage ionizing potential. Text compares mechanical and electronic tube rectifiers, electrodes utilised, removal of collected material. Special precipitators and precipitator limitations are discussed, as is precipitator efficiency and factors affecting it. Booklet tells where combination mechanical and electrostatic precipitators can be used. Western Precipitation Corp.

135 Use of Bolting Materials — "Modern Steel Bolting for Piping and Pressure Vessels" is a 14-pp article valuable in making the proper choice of bolting materials. It is pointed toward a practical understanding of the many specifications and grades. Includes a brief summary of the thinking behind allowable design values in codes and a review of assembly problems. Taylor Forge & Pipe Works.

136 For Pumping Viscous Liquids — A multiple V-belt drive pump unit for handling heavy fuel oils and other non-corrosive viscous liquids in circulating and transfer service is introduced in 8-pp Catalog 107. Illustrates typical applications, gives dimensions. Tuthill Pump Co.

137 Fuel Oil Additive — Technical Bulletin O-87 presents Santolene H, described as a fuel addition agent which prevents screen and filter clogging of oil burners. Results of tests — storage stability, screen clogging, diesel engine and rust — are given. Monsanto Chemical Co.

138 Safety Treads — Here's a 36-pp pocket-size reference booklet covering practically every type of safety tread application. Includes illustrated plates, cross-section drawings, typical installations and specifications for company's Safe-Groove and abrasive cast treads as well as expansion plates, platforms, curb bars and floor grids. Wooster Products, Inc.

139 Explosives, Blasting Supplies — Form 200-36 is a 60-pp booklet containing latest information on a line of industrial explosives and blasting supplies. Covers dynamites, gelatins, permissibles, dynamite cartridges, detonators, squibs and fuse lighters, blasting machines and aids. Provides a tabular summary listing properties of explosives and a list of safety "don'ts" for handling them. Hercules Powder Co.

140 Solutions to Scale Problems — Titled, "Solution to Your Problem of Scale and Corrosion Control," this pocket size 16-pp folder catalogs company's various Glucosates and their specific use in open and closed cooling water systems, boiler waters, brines, air conditioning equipment. Twelve Glucosates are listed with application in which each is most effective. D. W. Haering & Co., Inc.

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THIS MONTHLY list of standard catalogs and bulletins is published to help power engineers maintain a permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, may appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the catalogs and bulletins. Use the postage-free card below for your request

PUMPS, PUMPING

201 Centrifugal Pump Handbooks — Two instruction booklets covering the installation, operation and repair of company's single-stage single-suction and multi-stage centrifugal pumps are available. Suggest regular inspection procedures and include pages for maintenance records. Also provide handy tables explaining how to locate trouble and listing causes and cures. Bulletin 08X7813, 24 pp, covers single-stage pumps; Bulletin 08X7780, 48 pp, covers the multi-stage pumps. State choice or both. Allis-Chalmers Mfg. Co.

202 Rotary Pump Service Manual — The installation, operation and maintenance of rotary pumps are covered in 12-pp Service Manual 100-2. Subjects discussed include installing of foundation bolts, alignment, supporting vertical pumps, grouting, piping, suction lines, hot liquid pumps, rotation, packing, dismantling, reassembly, starting, operation and standing idle. Warren Steam Pump Co.

203 Condensed Pump Data — Form 4383-J covers more than 20 types of general service pumps, rotary pumps, sump and drainage pumps, condensate units, self-priming units, stainless steel pumps and high pressure pumps. In easy-to-find tabular form, each model is pictured along with its characteristics, applications, features and references to specific literature providing further information. Goulds Pumps, Inc.

204 Controlled Volume Pumps — Bulletin 351, 16 pp, describes company's air-powered controlled volume pumps, designed to pump practically any liquid in measured volumes accurate to within a fraction of 1 per cent. Pumps are reciprocating, positive displacement plunger types. Cross-sectionals show design and operating details. Controls and typical automatic feed systems are discussed. Milton Roy Co.

205 Boiler Feed Pump — A barrel-type boiler feed pump for high pressure, high temperature service and designed to go on the line quickly without preliminary warm-up, is the subject of 12-pp Bulletin 1525. Fully illustrated text explains automatic operation of hydraulic thrust balance incorporated in this pump. De Laval Steam Turbine Co.

206 For Controlled Volume Pumping — Bulletin 300, 24 pp, describes Pulsafeeder piston-diaphragm pumps, stressing their no-stuffing box feature and noting that although basically a pump, this unit can do the work of a feeder, meter, instrument, filling machine, proportioner and sampler. Process Equipment Div., Lapp Insulator Co., Inc.

207 Boiler Feed Pumps — Bulletin 109, 16 pp, illustrated in color, describes centrifugal pumps for boiler feed service. Pictures construction and major parts, floating seal incorporated. Capacity data and vapor pressure tables included. Pacific Pumps, Inc.

ELECTRICAL

208 Electrical Maintenance Tips — Booklet B-5477, 28 pp, gives a complete outline of preventive electrical maintenance. Discusses general maintenance programs designed to reduce shutdown time and treats in detail the maintenance of power equipment. A suggested schedule of work and cleaning on power equipment is presented in chart form. Essential information on preventive maintenance for turbines, generators, switchboards, motors and controls is provided. Westinghouse Electric Corp.

209 Wire, Cable Ordering Guide — Newly-released General Catalog W-52-S, 186 pp, presents more than 500 different types of wires and cables. Contains comprehensive data on construction and operating characteristics for control and signal cables, cables for construction work, telephone wire and cables, and portable cords. A technical engineering data section is included. United States Rubber Co.

210 Power Distribution Practices — The 28-pp "Industrial Power Distribution Idea Book" (Bulletin GEA-5900) is a guide on electric power distribution practices in large and small plants. Covers utility distribution practices; methods of buying electric power; what to do when a choice of primary voltages is available; application of primary switches and circuit breakers; types and arrangements of primary cables; and types of load-center distribution systems. General Electric Co.

VALVES, TRAPS, PIPING AND ACCESSORIES

211 Safety Valve Engineering Data — How company's safety valve works and its operating advantages are explained in Bulletin 707. Includes dimensions on valve types, and also tables on superheat correction factor. Manning, Maxwell & Moore, Inc.

212 Regulating Valves — Bulletin 313 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured body engineered for high capacity at low pressure drop. Leslie Co.

213 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principle of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

214 Valve Specialties — Included in 90-pp Catalog A-50 is ordering and engineering information on automatic pressure flow and liquid level controls for steam, air, gas, water, oil, other fluids. See-

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POWER ENGINEERING

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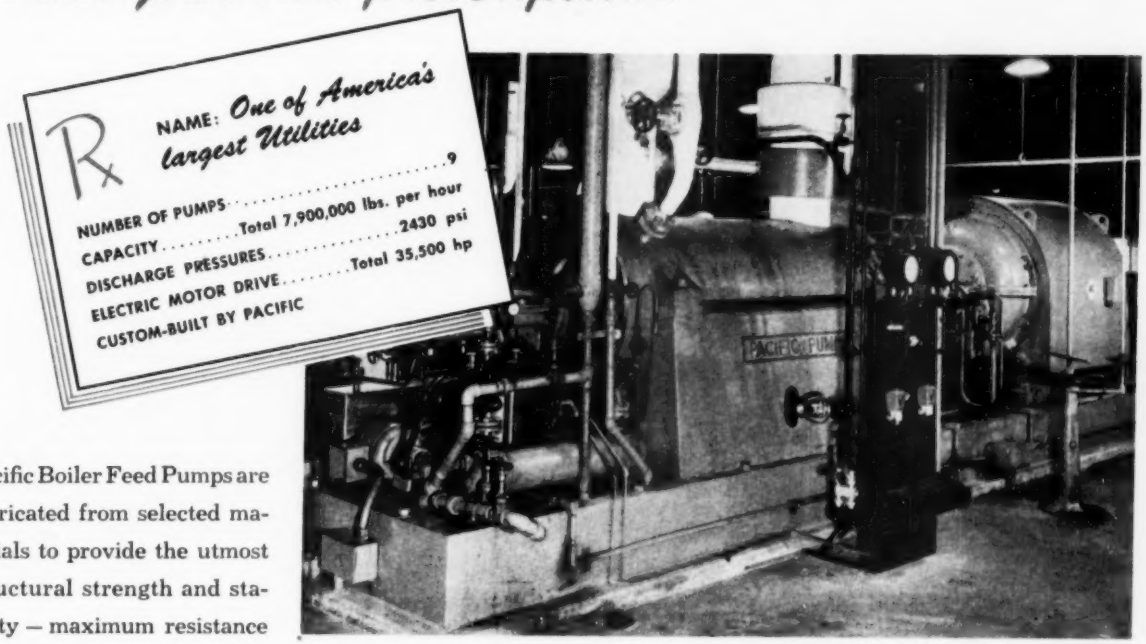

Pacific Boiler Feed Pumps are fabricated from selected materials to provide the utmost structural strength and stability – maximum resistance to corrosion-erosion and wear. Built in multi-stages for capacities to 2700 gpm; discharge pressures to 3000 psig; speeds to 5000 rpm.

Pacific SINGLE STAGE UNITIZED STEAM TURBO PUMPS

less unit cost–
less floor space–
steady dependable output!

Capacities to 500 gpm
Discharge Pressures to 1100 psi
Steam to 900 psi–850°F. TT
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Speeds to 10,000 rpm

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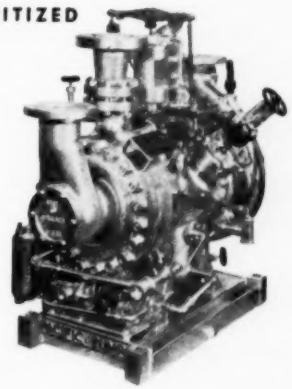

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This True Ball Joint Makes the Difference

DART UNIONS don't get tight, stay tight because of an ordinary "jammed" joint. Their tightness comes from a precision-ground, bronze-to-bronze ball joint that comes apart readily and remakes repeatedly — as tight as when new.

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Remember, the *extra* work life of a Dart is money in your pocket! Darts can be installed and reinstalled, time after time, with absolute assurance of tightness.

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tions are devoted to pressure regulators, altitude valve, pump governors and strainers; lever, float and motor operated valves; pilot valves; back pressure, relief and non-return valves, steam trap and air vent; liquid level controllers; solenoid valves. Davis Regulator Co.

215 For Quick Valve Selection — Here's a 20-pp catalog digest providing ordering and application information on gate, globe, angle and check valves in bronze, iron, cast and forged steel construction, also valve accessories and parts. Illustrated and thumb indexed, includes pressure-temperature chart. The Ohio Injector Co.

216 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blowers, water column blow-down, and other types of pipe line. Everlasting Valve Co.

217 Cast Steel Valves — This 56-pp catalog on cast steel valves includes information on globe, angle and check valves in 300, 600, 900 and 1500 lb pressure classes. Parabolic disk valves for hand or motor control of volume are also described. In addition to standard information on construction features, dimensions and weights, the booklet contains complete data on material specifications, preparation of welding ends, flange facings, and pressure-temperature ratings. Edward Valves, Inc.

218 Gate Valves — Literature is available on cast steel outside-stem-and-yoke gate valves; also on bronze, iron, steel and corrosion-resisting valves in a variety of types. The Wm. Powell Co.

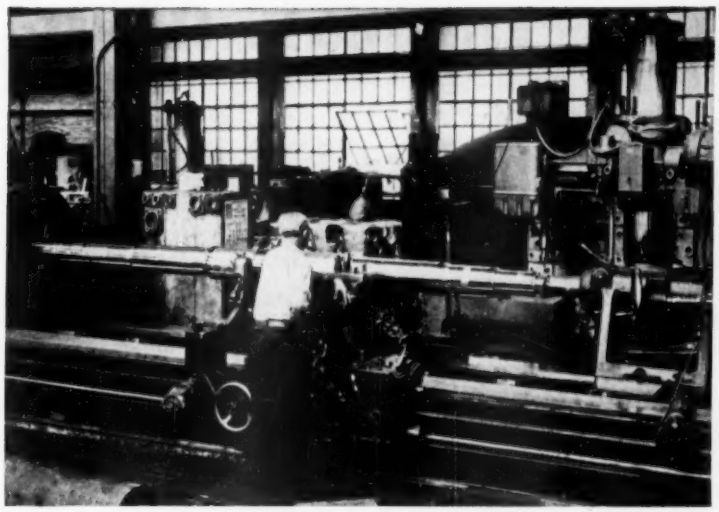
219 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

220 Solving Steam Trap Problems — This 36-pp catalog on steam traps contains specifications and capacities on steam traps, float traps, air release valves and pipe line strainers. Tells how to calculate condensation loads and select traps for all classes of equipment, including unit heaters, jacketed kettles, autoclaves, submerged surfaces, steam mains and header drips. Gives pointers on how to install and service traps. The V. D. Anderson Co.

221 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

222 Steam Trap Reference Manual — Bulletin T-1740, 24 pp, tells why and where steam traps should be used; explains desirable trap features. Advantages of company's impulse steam traps are described, their operation illustrated. How to figure trap sizes and how to size condensate return lines are told and capacity and pipe dimension charts and thermodynamic properties of saturated steam included. Yarnall-Waring Co.

When you need a tough, fatigue- and corrosion-resisting alloy —try "K" Monel



This is the largest INCO Nickel Alloy pump shaft in the world. The shaft is 13 feet $7\frac{1}{8}$ inches long, 9.005 inches at its widest diameter, and weighs 3,343 lbs. It was forged by INCO'S Huntington Mill from "K" Monel for Consolidated Edison Co., after other materials repeatedly failed.

Are there applications in your operation where metal is subject to fatigue, corrosion and erosion?

Then chances are "K" Monel is the alloy you need.

"K" Monel is a tough, corrosion-resisting wrought alloy of Nickel, copper and aluminum. It offers you the excellent corrosion resistance of regular Monel, together with the added advantages of greater stiffness and hardness through heat treating.

As evidence of the value of "K" Monel's added advantages, take a pump shaft operating in highly corrosive and polluted salt water.

New York City's Consolidated Edison Company has two big 80,000-gallon-per-minute condenser circulating water pumps. For years engineers kept replacing the shafts with materials of increasing strength but failures would continue to occur in the same spot because of corrosion fatigue.

Finally, they decided to try "K" Monel.

A 1½-ton heat-treated "K" Monel shaft with a tensile strength of 140,000 pounds per square inch was installed in September of 1949 and has been functioning perfectly ever since. In fact, the pump casing has not even been opened for inspection since installation.

Let's take a quick look at a few of the principal characteristics of "K" Monel:

Age-hardenable, or capable of having its hardness and mechanical properties increased simultaneously as the result of thermal treatment, "K" Monel is equal in strength and toughness to many heat-treated alloy steels. It shows improved strength and hardness at sub-zero temperatures with no loss of toughness. And it provides moderate strength at temperatures up to 900° F.

"K" Monel is non-magnetic under ordinary conditions, and remains so down to −150° F.

The working characteristics of "K" Monel are excellent, too. It is readily machined in an annealed condition, but in other conditions may be considered commercially machinable at practical (although generally somewhat slower) rates. It can be joined by the usual welding, brazing and soldering processes.

You'll find all essential engineering data on "K" Monel and its more machinable companion alloy, "KR" Monel, in the 24-page reference manual, "Engineering Properties of 'K' Monel and 'KR' Monel." Write for your copy.

At present, INCO Nickel Alloys are in great demand for defense purposes. It pays to anticipate your equipment needs as far in advance as you can, and then place your orders with suppliers at once.

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Nickel (INCO TRADE MARK) **Alloys** MONEL® • "R"® MONEL • "K"® MONEL "KR"® MONEL • "S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL® • INCONEL® INCONEL "X"® • INCONEL "W"® • INCOLOY® • NIMONICS®

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Eliminate the Danger of

INTERCRYSTALLINE CORROSION

ALLIS-CHALMERS WATER CONDITIONING
Equipment — Chemicals — Service

Photomicrograph of edge of crack caused by intercrystalline corrosion. U. S. Bureau of Mines detection unit (inset) tests for causes of intercrystalline corrosion.

Dangerous and costly cracks due to intercrystalline corrosion (embrittlement) will be no problem in your boilers if you have given careful consideration to the problem *in advance*. You can get the information you need to analyze your operations from Allis-Chalmers water conditioning Bulletin 45. It explains intercrystalline corrosion — the cause of embrittlement. It tells what tests are necessary to recognize this condition. And it discusses what you can do.

Get the Answer to Many Problems

Bulletin 45 is one of a series of Allis-Chalmers bulletins on water conditioning problems. Like all of these useful bulletins, it is based on the wide experience of Allis-Chalmers water conditioning men in handling water problems for nearly every industry. In addition, it is based on Allis-Chalmers long experience building turbines and power plant equipment.

Complete Service Available

Allis-Chalmers gives you complete water conditioning service. You can get analyses and reports on your problems. You can get the chemicals needed in all water treatments. And you can get the equipment for any system.

A-4014

For your copy of Bulletin 45 on intercrystalline corrosion, write Allis-Chalmers, Milwaukee 1, Wisconsin. Or better, call your nearby Allis-Chalmers district office and have an Allis-Chalmers representative consult with you on your water problems.

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223 **Steam, Air and Gasoline Traps** — Illustrated Catalog 751, 32 pp, provides capacity tables, installation diagrams and a section containing data, charts and formulas for determining proper size trap for specific applications. Covers thermostatic steam traps for pressures to 225 lb, expansion steam traps, weight-operated traps for steam, air and gasoline, also piston-operated traps. W. H. Nicholson & Co.

224 **Piping Pointers** — This is company's highly popular 36-pp manual covering fundamentals of sound piping practices. Discusses various types of valve designs and how each should be used. Pictures and names more than 80 fittings and contains illustrated how-to-do-it features. Includes 8 pp valve selection guide. Crane Co.

225 **Unions and Fittings** — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special features. Dart Union Co.

226 **Handbook on Fittings, Flanges** — Catalog wf-1950, 68 pp, offers working information on seamless carbon steel welding fittings and forged steel flanges. Includes dimensional tolerances, thread standards and threading practice; service pressure ratings, physical and chemical requirements. Grinnell Co., Inc.

227 **Forged Fittings** — Literature is available on screw-end and socket-weld fittings. Stresses economy and other advantages of these fittings, lists steels available. Watson-Stillman.

228 **Duplex Strainer** — This literature describes company's Duplex strainer with single handwheel control. Shows how it is designed with only one stuffing box and can be cleaned under full flow. R. S. Products Corp.

229 **Data on Strainers** — Several types of pipe line strainers for all purposes in sizes from ½ to 36 in. are described and illustrated in 16-pp Manual 951. Summarizing important developments, booklet carries information on factors to consider in selecting a strainer for a specific application. J. A. Zurn Mfg. Co.

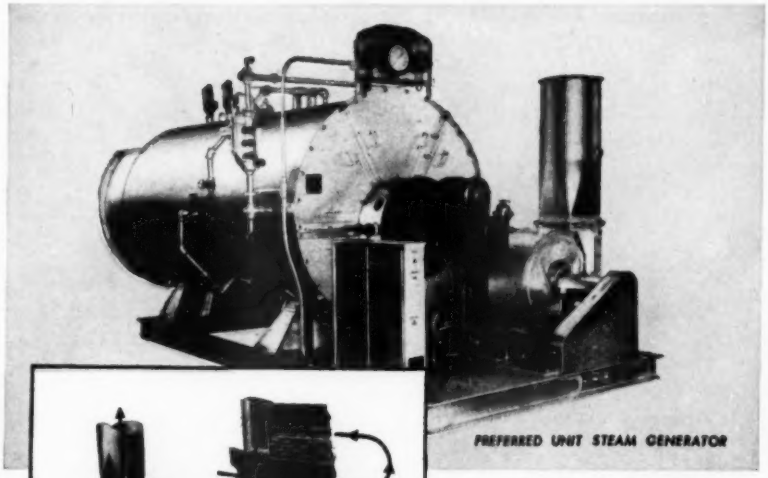
BOILERS, GENERATORS

230 **Improved Steam Generator** — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions and standard and accessory equipment for the units which range from 20 to 6000 hp, for pressures to 250 psi. Preferred Utilities Mfg. Corp.

231 **Shop-Assembled Boiler** — Sixteen-pp Bulletin G-76, completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. Savings in erection, installation and moving costs are stressed. Capacities, dimensions and weights given. The Babcock & Wilcox Co.

232 **Re-circulation Steam Generator** — Here's a 6-pp folder on a controlled

there IS a difference...*



*Expansile Precipitator for maximum gas velocities in all tubes. This is another one of the many "Preferred's" 25 year built-in features.

PREFERRED *can do the job* and do it BETTER!

Another one of a long list of *exclusive* "quality features" of the Preferred Unit Steam Generator is the Expansile Precipitator which helps "Preferred" to do the job better . . . because it is designed and engineered to perform better!

This Preferred component enables maximum gas velocities to be equally maintained in all tubes of the pressure vessel. This is particularly important in the last pass where any drop in velocity (due to obstructions or insufficient mechanical impetus) results in rapid build-up of deposits. The expansile precipitator prevents this build-up, thus minimizing maintenance costs. The Preferred Expansile Precipitator is your overall insurance for clean, smokeless operation and healthful working conditions . . . trapped impurities *cannot* escape to surrounding areas.

The Preferred Generator gives economical, low-maintenance service at *a minimum guaranteed efficiency of 80%* . . . for twenty-five years. The Preferred Unit Steam Generator is insurance for optimum combustion based on automatic and simplified operation.

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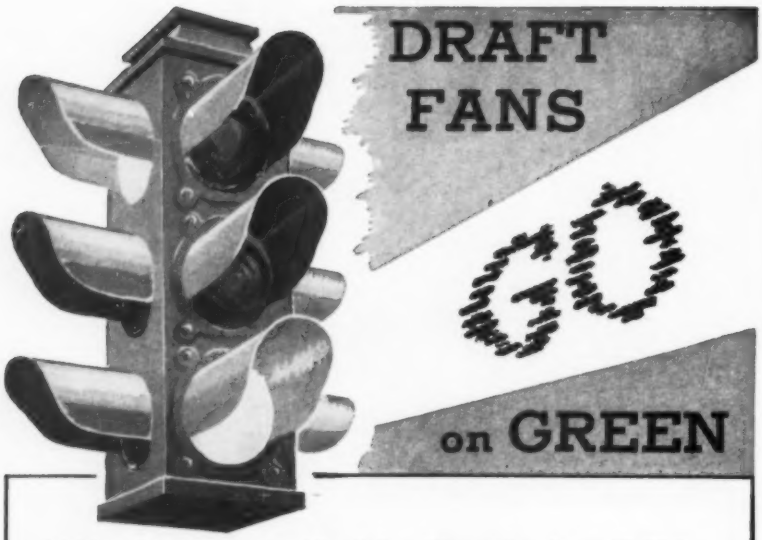

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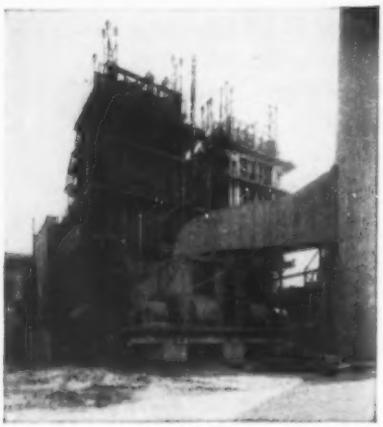
One significant fact about Green Fan Installations at the New Orleans Public Service Plant is that two different boiler manufacturers were involved . . . two different types of boilers but Green Draft Fans for all three boilers. Each boiler has two Green Induced Draft Fans and one Green Forced Draft Fan.

When a concern has specialized on an important piece of power plant equipment for many years, that firm is rightly called the "authority" on the subject. This is the position of Green Fuel Economizer Co. in the field of mechanical draft fans. The name Green is synonymous with Draft Fans highly acceptable to industry.



The Line of Green Induced and Forced Draft Fans includes many types in many sizes which are described in Bulletin No. 168. We shall be glad to discuss your fan requirements with your own engineers, with your consulting engineers and with the boiler manufacturer of your choice.

THE GREEN *Fuel Economizer* COMPANY INC.

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re-circulation steam generator, describing its development and uses, such as applications where steam is required in remote locations, where demands are intermittent, or load fluctuating. Combustion Engineering-Superheater, Inc.

233 Steam Generators — Twenty-pp Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-tube boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Use of generator with various fuels and firing arrangements is covered. Erie City Iron Works.

234 Steam Boilers — Form SG 128-749 is a 12 pp catalog illustrated with photos of steam boilers for processing and heating, ranging from 15 to 500 hp and 15 to 200 psi. Includes diagrammatic cross-section of four-pass design characteristic of company's boilers. Cleaver-Brooks Co.

235 Scotch Marine Boilers — Bulletin 236 illustrates and describes a Scotch type of boiler on skids suggested for a wide range of applications. This boiler can be hand- or stoker-fired with coal or can use oil, gas or wood as fuel. Gives construction details, stresses versatility, other advantages. Includes test data and specifications. The James Leffel & Co.

236 Oil or Gas Fired Automatic Boilers — Boiler, burner, controls and safety features of 10 to 500 hp oil or gas fired automatic boilers are described in this bulletin. Firing rates, dimensions and capacities are given for all models along with installation photos of some models. Boiler Engineering & Supply Co.

TUBING AND ACCESSORIES

237 Condenser Tubes — Excellent information on condenser tubes and their service life is given in this 40-pp illustrated booklet. Subjects discussed include corrosion of condenser and heat exchanger tubes, corrosion resistance and control, the selection of tube materials, and the composition and physical properties of company's alloys. Details on proper installation are presented, as are specifications, conversion tables, weights of tubes and alloys. Scovill Mfg. Co.

238 Life Extension for Condenser Tubes — This 32-pp extensively illustrated booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

239 Nickel Pipe and Tubes — Bulletin T-17 is a 27-pp technical bulletin on the fabrication and design of nickel and high nickel alloy pipe and tubing, illustrated throughout by drawings and photos. Presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures. The International Nickel Co., Inc.

240 Double-Walled Tubing — Technical Bulletin 1950, 12 pp, presents tubing designed for conditions where single-walled tube can't withstand simultaneous attack from two types of corrosive media. Describes and illustrates construction, illustrating possible metal combinations.

It will pay you as it has paid others to

Specify Revere

CONDENSER TUBES AND PLATES

It is significant that year after year important users of condenser tubes and plates specify Revere, not only for new equipment, but when re-tubing. You might consider this fact if you are not as yet a Revere customer.

Remember that Revere can give you more than tubes and plates. If you have questions regarding the most suitable alloy to meet operating conditions, the Revere Technical Advisory Service will be glad to collaborate with you on this subject. If your present tubes do not seem to be giving the service expected of them, the same Service will look into the matter. Such factors as vibration, air entrainment, water velocity, impingement attack, changed water conditions, tube composition, and others will be studied and recommendations made. In a great many cases we have pointed the way to greater tube economy, increased service life.

As part of our service to condenser operators we have prepared a 28-page booklet entitled "Life Extension for Condenser Tubes." Ask for it on your company letterhead and it will be sent free.

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Chlorination equipment because it controls slime that *grows* on the walls of condenser tubes not protected against it. Enough of the growth eventually seriously reduces heat transfer efficiency — actually *insulates* your steam from the cooling water. Back pressures go up, production drops, operating and maintenance costs rise, and eventual shut-down becomes necessary for regular clean-out periods.

Wallace & Tiernan equipment because it is versatile, sturdy and dependable — proven by thousands of successful installations, vouched for by satisfied users everywhere-and because there's a Wallace & Tiernan chlorinator for every job. Write today for information on how Wallace & Tiernan chlorination may help you solve *your* slime problem.

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regardless of the source. Chlorination helps reduce slime in make-up or cooling water.

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Explains tubing's use in ammonia refrigeration, boilers, steam generators. Discusses heat transfer properties, high temperature use. Bridgeport Brass Co.

241 Tube Cleaners — Catalog 76-A provides 48-pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Electrically driven equipment, air valves, hose, lubricators presented. Thomas C. Wilson, Inc.

242 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Roto Div., Elliott Co.

HEAT EXCHANGING, COOLING

243 Heat Exchangers — The advantages of film-type heat exchangers in the solution of cooling water problems, even when dirty water must be used, are stressed in Bulletin HE-7, 8 pp. Explains and illustrates design details. Discusses use of these heat exchangers in power plants, chemical plants, and in a compression plant. Henry Vogt Machine Co.

244 Finned Tube Heat Exchanger — Bulletin 1400, 20 pp, fully describes the company's G-R Twin G-Fin Section heat exchanger. The unit has wide application for heating and cooling liquids and gases, and for condensing vapors, according to the company. Suitable as boiler feedwater preheaters, fuel oil heaters, etc., features of design and construction are given. Specifications and dimensions are included. Griscom-Russell Co.

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245 Cooling Towers — Bulletin AQ-50 is on packaged water cooling towers in 3 to 50 t sizes. Gives specifications for the tower and discusses special features. Also provides dimensional and application data. The Marley Co., Inc.

246 Heat Exchanger for Process Industries — Bulletin HF-101, 8 pp. introduces the Holo-Flight Processor, a new heat exchanger. Tells how it affords control of the flow of material as to duration of treatment, and control of the quantity and temperature of heat exchange agent. Western Precipitation Corp.

FUEL OILS, LUBRICANTS

247 Cooperative Technical Consultation Service — This informative 24-pp booklet presents company's periodic consultation service aimed at the most

ECLIPSE FUEL ENGINEERING WRITES:

"Heat Prover Completed a 30 Hour Burner Test In Just 6 Hours!"

Amazing Cities Service Heat Prover Works 5 Times As Fast As Old Method... More Accurate, Too!

Robert W. Pixler, Laboratory Supervisor for Eclipse Fuel Engineering Company, Rockford, Illinois writes:

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"Our test work with previous instruments was a long, drawn-out affair. But with the Heat Prover, we completed what would normally have been a 30-hour test in just 6 hours! ...and we doubt that our old equipment could have maintained the accuracy delivered by Cities Service Heat Prover."

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QUALITY PETROLEUM PRODUCTS

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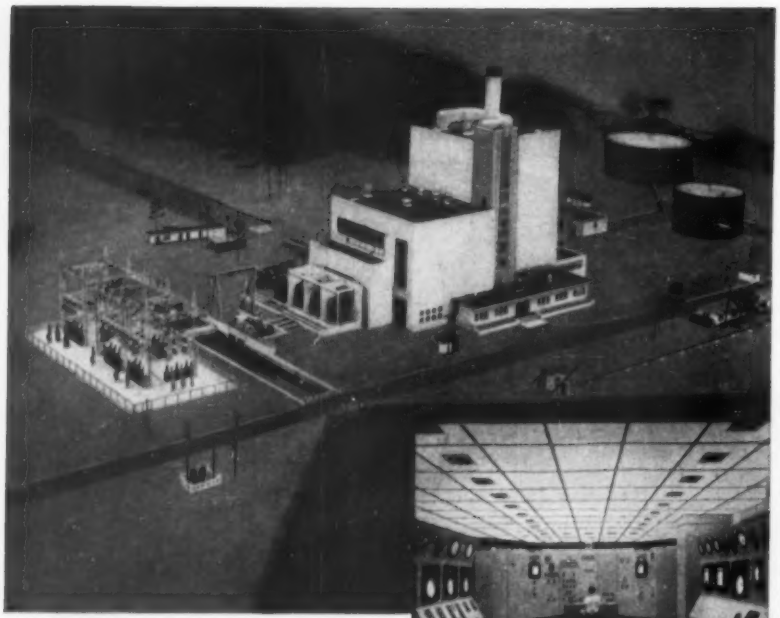

Aerial view, Higgins Plant

Boiler, turbine and duplex switchgear panels in centralized control room.

Engineering & Construction

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efficient use of petroleum products. Covers services available in the solution of lubrication problems, metalworking operations, processing, fuel oils, dust control. Gulf Oil Corp., Gulf Refining Co.

248 Air Compressor Lubrication Manual — Valuable information on air compressor maintenance is contained in this 40-pp book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, also safety precautions. Cities Service Petroleum, Inc.

249 Lubrication of Diesel Engines — An excellent instruction manual, 50-pp Technical Bulletin B-1 (revised) also provides a brief history on diesel engines, an explanation of the fundamentals of design and the common types of diesels and their advantages. Explains combustion process, discusses modern fuel injection systems. Cylinder and bearing lubrication are treated and recommendations given for lubricating oils. Sun Oil Co.

250 Diesels, Their Fuels and Lubricants — This 46-pp book gives practical information on diesel engines, covering their history and economics as well as design characteristics and operating principles. Classification of diesels according to their speed is also explained. Sinclair Refining Co.

251 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, their uses and physical properties. Standard Oil Co. (Ind.)

252 Turbine Lubrication — The special problems of turbine lubrication are discussed in 8-pp Bulletin TU-1. Tells how purifiers keep power units in service; discusses inhibited and uninhibited oils, company's process for reducing sludge formation within lubrication system. Illustrated with diagrams of typical installations, photos of purifiers. DeLaval Separator Co.

253 Turbine Oil Conditioning — Bulletin 832-P, 12 pp, offers a detailed explanation of the reasons for turbine oil conditioning, the way in which company's dry type conditioning equipment nullifies or prevents factors which promote deterioration of oil. Bowser, Inc.

FUEL BURNERS

254 Gas Burners — Illustrated Bulletin 410-8, 16 pp, furnishes descriptive and technical data on company's gas burners and combination gas and oil burners, giving design details and explaining operation of each. Coppus Engineering Corp.

255 Oil Burning Equipment — Bulletin O-B, 37 contains 16 pp of technical information on company's oil and gas burning equipment, steam atomizing burners, mechanical atomizing burners, interchangeable burners, telling best applications, including capacity data. Also shows fuel oil pumping, heating systems. The Engineer Co.

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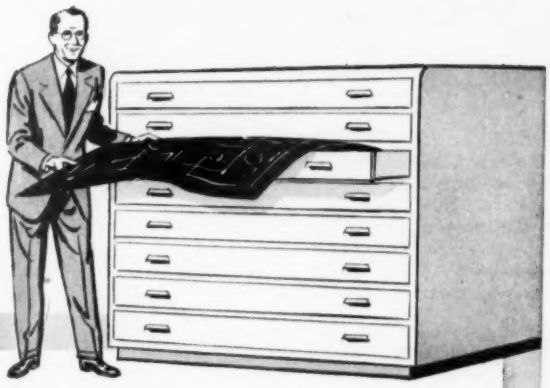

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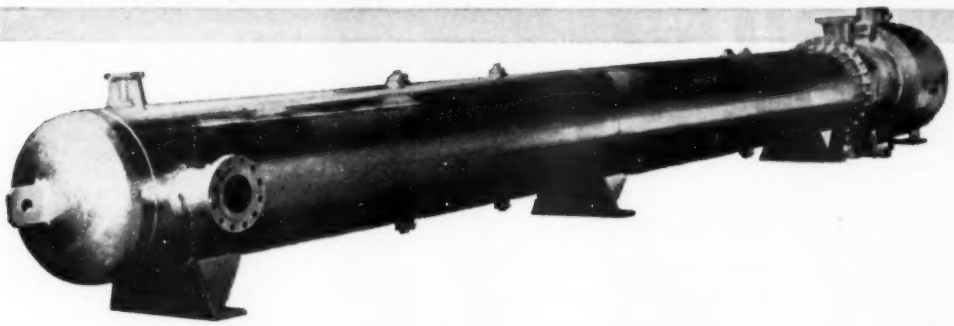

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256 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomizing the oil. Discusses steam and oil control valves. National Airoil Burner Co., Inc.

COAL, ASH HANDLING

257 Where Refuse Is Fuel — Presented in 24-pp Bulletin are installations of company's stokers with medium-size and larger units burning refuse fuels, separately or in combination with coal. Lists many of the refuse fuels handled successfully by this type of spreader stoker. Detroit Stoker Co.

258 Coal Scale — Bulletin 0250, 12 pp, describes a pressure-tight, automatic coal scale, its construction and operation. Shows how beam system, electrical components and linkages are protected from coal dust. Richardson Scale Co.

259 Economic Coal Storage — How tractors establish safe, orderly coal handling is told in this 8-pp booklet. Stresses flexibility, low operating costs. Also shows how tractors speed storage reclamation and how a tractor-scraper combination offers plus benefits. Illustrated with action photos; picture several models. Tractor Div., Allis-Chalmers Mfg. Co.

260 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly ash control, coal storage pile treatment and boiler cleaning. Johnson-March.

261 Spreader Stoker Data — This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

262 Spreader Stoker Selection — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

263 Shredder Ring Crusher — A crusher for coal and similar materials which features rolling shredder rings is described in this 8-pp bulletin. Gives details on a survey of 29 mines and power plants in which this type crusher is installed. Informative tables giving speed, capacity, horsepower, weight and dimensions of crushers, as well as cost data are included. American Pulverizer Co.

WATER CONDITIONING

264 Water Conditioning Data Book — Recently revised, this pocket-size 116-pp booklet presents a compilation of 77 tables, all valuable to the power engineer. Covers such subjects as hydraulics, impurities in water, boiler feed-water make-up requirements, chemical conversions and chemical reactions. Contains excellent reference information on many phases and methods of water treatment. Available without charge to qualified power engineers. The Permutit Co.

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265 What's What on Ion Exchangers — Here are three booklets on ion exchangers: Nalcite HCR, a styrene type cation exchanger; Nalcite SAR, a strongly basic anion exchanger; and Super Nelcolite, a synthetic gel type zeolite for cation exchange. Tables and graphs explain performance of these water treating resins under various operating conditions. Physical characteristics, exchange capacities, regeneration techniques discussed. Bulletin 57, 20 pp, is on Nalcite SAR; Bulletin 58, 28 pp, Nalcite HCR; Bulletin 59, 8 pp, Super Nalcolite. State those wanted. National Aluminate Corp.

266 Modern pH and Chlorine Control — This 100-pp booklet gives details in color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

267 Steam System Treatment — This bulletin on Coravol for prevention of corrosion, explains theory of corrosion, application of organic amines to steam systems (the Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing special chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

268 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising pH value of condensate. The Bird-Archer Co.

269 Boiler Scale — Formation and Prevention — Technical Paper 98 is a 12-pp article covering the cause and prevention of boiler scale. Covers the mechanism of scale formation, effect of boiler scale, chemistry of scale formation, internal chemical treatment and chemical correctives. Diagrams of feeder systems, photos and solubility charts illustrate text. W. H. & L. D. Betz.

270 Boiler Water Manual — Factual information on methods of applying chemicals in treatment of water for boilers is presented in 16-pp Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and feed-water system, condensate returns. % Proportioneers, Inc. %

271 New Data on Zeolite Softeners — Publication 4520-A is a recently revised edition of company's booklet on zeolite water softening. Provides a glossary of terms used in the process, data for laying out a zeolite softening plant, factors governing size of equipment, selection of zeolite materials and discussion of the four stages of operation of a sodium zeolite softener. Cochrane Corp.

272 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treat-

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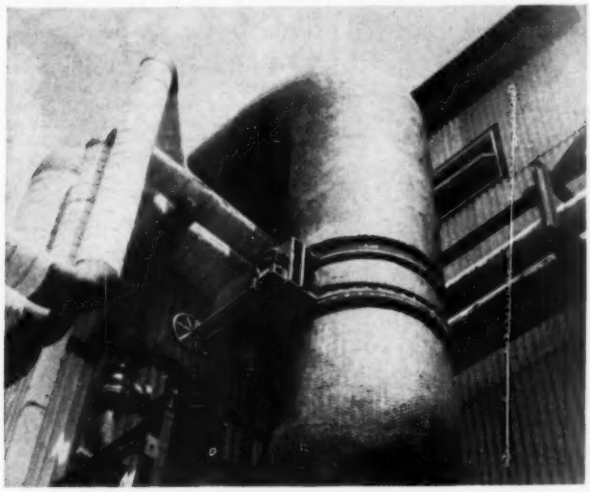

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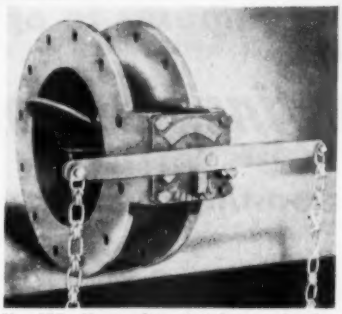
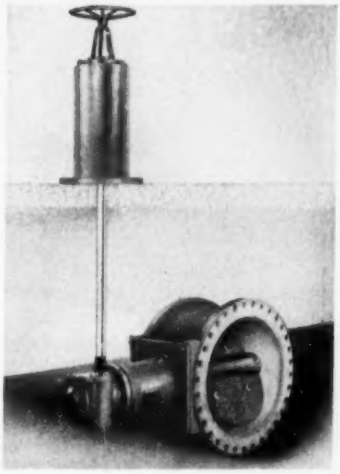
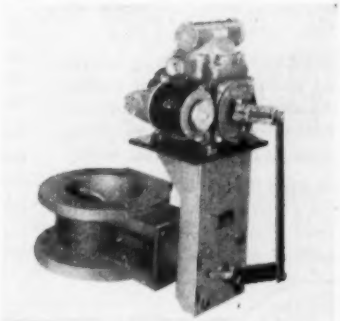


No. 688—Heavy duty chainlever valve for quick opening or closing in elevated and inaccessible locations. R-S Valves are used to control and shut-off the volume and pressure of nearly all materials in the temperature range from minus 300° to plus 2000° F. 2 to 2500 psig.

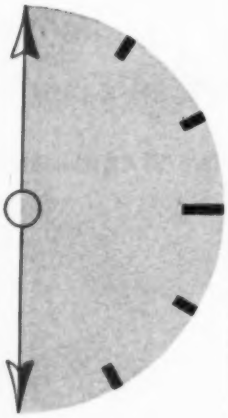


No. 788—Heavy duty valve equipped with rubber seat, totally enclosed gear reduction drive, extended shaft and floor stand. Positive shut-off is obtained up to 125 psig with rubber seated valves and commercially tight shut-off to even higher pressures with a babbitted seat.



No. 839—8-inch heavy duty valve equipped with 125-pound flanges, 18-8 shafts, bronze bushings and a throttling type motor operator for the control of low pressure air.

. . . it takes only 30 minutes to open a Continental Boiler for cleaning or inspection



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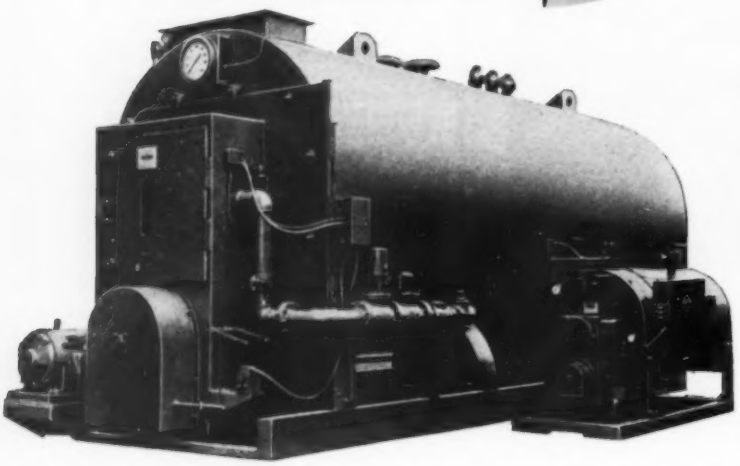

With a Continental you'll hold boiler down-time to a minimum because the clean-out-and-inspection-doors at both ends are hinged and can be handled *easily* by *one* man.

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Continental Boilers are shipped tested and ready to operate. No special stack, foundations or connections required.

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ment application, blow-down adjustment, test control. Describes equipment. Dearborn Chemical Co.

273 Feedwater Treatment — Here is a 10-pp illustrated report on boiler feedwater treatment for a high-pressure, high-makeup power and steam producing plant. It is based on studies to determine best method of meeting requirements for both the high-pressure steam used in power generating turbines and the district heating steam for downtown Philadelphia. Graver Water Conditioning Co.

274 Microbiological Control — Technical Article 3C, 12 pp, is an illustrated discussion of microbiological control of and through industrial waters. A section on industrial water chlorination covers cooling waters and process waters. Other sections deal with chlorine metering in chemical processes, and the sanitary aspects of industrial water treatment. Wallace & Tiernan.

275 One-Minute Water Tests — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50. Procedures, reagents, and equipment are described. Hall Laboratories, Inc.

REFRACTORIES, INSULATION

276 Industrial Insulations — Just released, this 20-pp catalog describes insulating materials covering the temperature range from −150 to 1800 F, and including cement, block, blanket, felt and pipe covering. Complete with thermal-conductivity graphs and heat loss charts, catalog also shows list prices. Brief application descriptions included, also typical uses, sizes, packaging, densities. Baldwin-Hill Co.

277 Refractory Cements — Sixteen-pp Form 863, presenting a line of refractory cements, discusses the three basic materials used in them, provides a detailed selection guide and illustrated discussion on methods of preparation and installation. Also defines terminology. Norton Co.

278 Heat Insulation Data — This is a 12-pp illustrated engineering and specification manual describing applications for 85 per cent Magnesia heat insulation. Provides data on heat savings per pipe thickness, for heat ranges to 600 F. Includes charts for determining thickness standards for pipe covering, with tables for heat calculations. Mundet Cork Corp.

INSTRUMENTS AND CONTROLS

279 Supervisory Instruments — Catalog 90-2, "Supervisory Instruments for Power Generation," consists of 41 pp on the instrumentation involved in generating stations. Separate sections cover steam generation instrumentation, turbine and generator instrumentation, electrical distribution instrumentation and diesel engine instrumentation. Measurement of temperature, pressure, flow, power generation and other variables discussed. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

280 For Practical Men — This 24-pp pocket-size booklet presents insulation testing in simple language. Packed with maintenance hints, explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester, justifies cost in long run economy. James G. Biddle Co.

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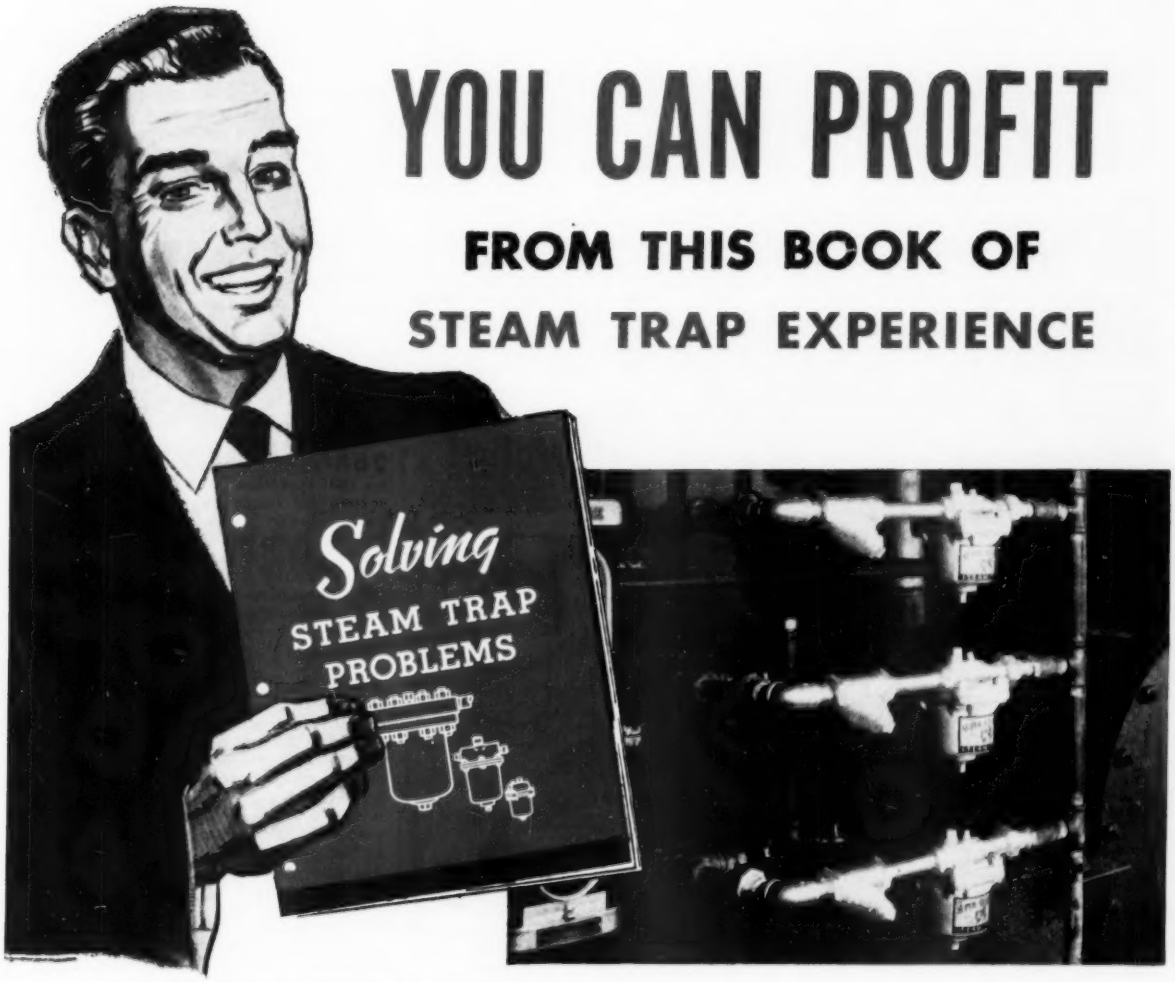

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281 Industrial Thermometers — Catalog 125, 28 pp, presents ordering data on a wide range of industrial thermometers, giving scale ranges, dimensions and prices. Features company's Adjust-Angle thermometer designed for use at any angle front to back, left or right, through a 180 deg arc. Gives construction details and advantages of this adjustable-stem type instrument. Weksler Thermometer Corp.

282 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

283 Sight Glass Flow Indicators — Twelve-pp Bulletin 18-W, on company's line of flow indicators, shows how these mechanical devices indicate fluid flow and its direction in pipelines which can be directly observed through a sight glass and are suitable for service with liquid, gas, vapor, slurry or sludge sufficiently translucent to permit observation of indicating element. Schutte and Koerting Co.

284 Oxygen Analyzers, Recorders — Bulletin 105, 6 pp, describes and pictures oxygen analyzers and recorders giving their general characteristics, and features, explaining their paramagnetic principle of operation, and discussing their applications. Covers both deflection and null type analyzers; discusses sampling requirements. Arnold O. Beckman, Inc.

285 Pressure Regulator — Bulletin 1-B, 8-pp discusses design, operation and applications of a super-sensitive pressure regulator; shows typical installations. Also covers a compound regulator for back pressure relief valve. Atlas Valve Co.

286 Electronic Control System — Bulletin A-701 introduces company's Autronic system, a miniature all-electronic system for controlling pressure, temperature, flow and level, intended for use in chemical processing plants, refineries, central stations, other applications where fast, accurate control is required. The Swartwout Co.

287 Instruments Control Systems — Twelve-pp Catalog 513 presents manufacturer's line of instruments, control systems, regulating valves and desuperheaters. Covers draft and pressure instruments, boiler meters, recorders, thermometers, regulators, combustion controls, pump controls and many others. Republic Flow Meters Co.

288 Boiler Control — Ten-pp Bulletin 1007 describes a completely integrated system for controlling combustion, feed water, boiler steam temperature and boiler cleaning, available in a single package or furnished separately. Illustrated with full color drawing of complete control, photos of recorders, drive unit. Covers instrumentation with both miniature and standard instruments. Copes-Vulcan Div., Continental Foundry & Machine Co.

289 Panel Planning Ideas — The engineering and economical planning of modern combustion and process control panels is discussed in 8-pp Bulletin 170. Numerous panel designs, fashioned for control, are illustrated along with the most up-to-date methods of tubing and wiring. A section on accessories helps make this a valuable source book of ideas for control station planners. Bailey Meter Co.

290 Control Centers — This 31-pp application booklet (B-5621) on control centers stresses the case for centralizing all controls of an entire system in one group of enclosures. Discusses the characteristics of control centers that make for flexibility of use, ease of servicing, safety. Three types are described, and the various electrical components that make up typical units are illustrated. A three-step building-block system of planning control centers is given. Westinghouse Electric Corp.

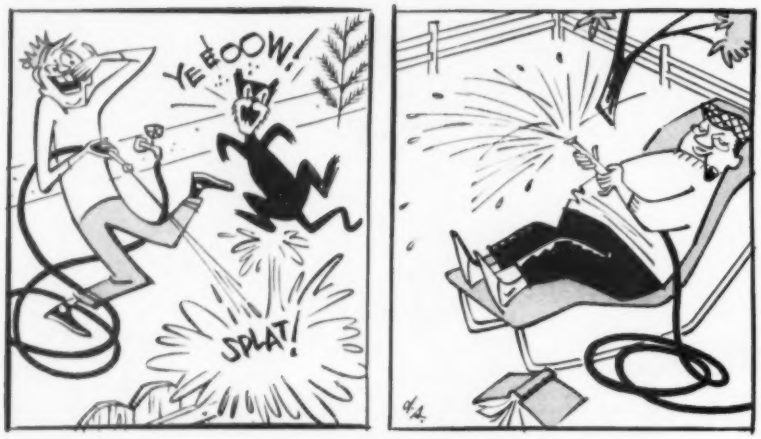
291 For Combining Control Signals — The improved design of company's Ratio Totalizer is described and pictured in 8-pp Bulletin 5452. This simplified versatile mechanism is a pneumatically operated control for combining input control pressures and spring forces, and producing an output control pressure based on addition, subtraction, multiplication, division or other functions. Hagan Corp.

PACKINGS, GASKETS, SEALS

292 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing specific recommendations for a wide variety of applications. Packing Div., Raybestos-Manhattan, Inc.

293 Seals for Bearings — Complete information on manufacturer's Klozure oil and grease seals for bearings is available in 100-pp Catalog 10. Fully illustrated in color, pictures all types of these seals,

There's a RIGHT Way to Use Water!



There's a WRIGHT Way to Solve Your Water Conditioning Problems!

The many uses of water in industry naturally result in a wide variety of water conditioning problems. Few are alike. Each problem requires an individual study and a solution tailor-made to fit specific conditions.

This individual approach is the reason hundreds of plants are now using Wright Preventive Maintenance Service to control, and in many cases eliminate scale, corrosion or any other problem related to the use of water.

The Wright Service starts with a field survey and scientific laboratory analysis of *your* problems, followed by a written proposal for the solution . . . a solution based upon our specialized knowledge gained in years of practical water conditioning experience. To insure proper performance, we make constant checks after the Wright recommendations have been adopted.

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Conserve those valuable condenser tubes...

the Wilson Way

Usually a surface condenser tube fails in the first few inches of its length due to inlet end erosion. To protect against this costly deterioration, it is good practice to paint the tube sheets as well as the tube ends with a protective coating. This low-cost cleaning and application kit is designed to do the job quickly and efficiently. Only three simple steps are needed: (1) Clean all the tube ends. (2) Thin coating and squirt it into tube. (3) Attach the paint brush to the air motor and use it for fast, easy spreading.

This Wilson method insures complete removal of dirt, provides excellent paint adherence, makes certain paint is spread evenly on the tube. The work can be done in a hurry . . . with any labor available.

The Wilson Cleaning and Application Kit is but one of many Wilson accessories designed for the proper maintenance of condensers and heat exchangers. For packed condensers, there are packing tools, packing removal counterbores and ferrule wrenches. Wilson also makes a wide range line of tube cutters, tube expanders, flaring and belling tools, tube pullers, etc. TW 822

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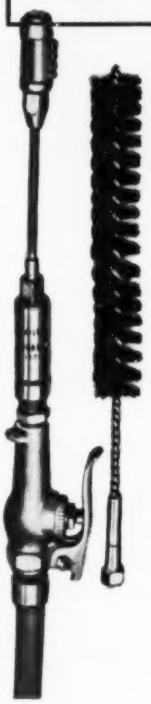

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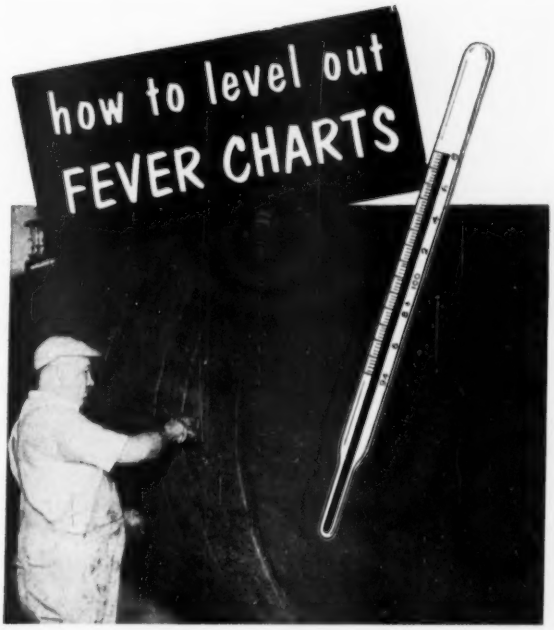

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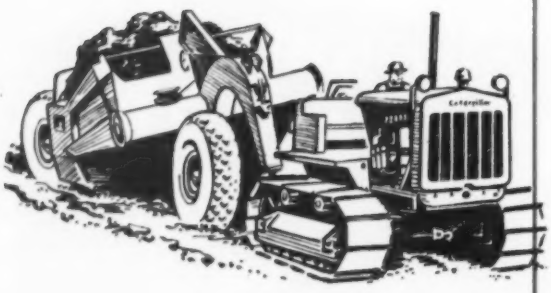
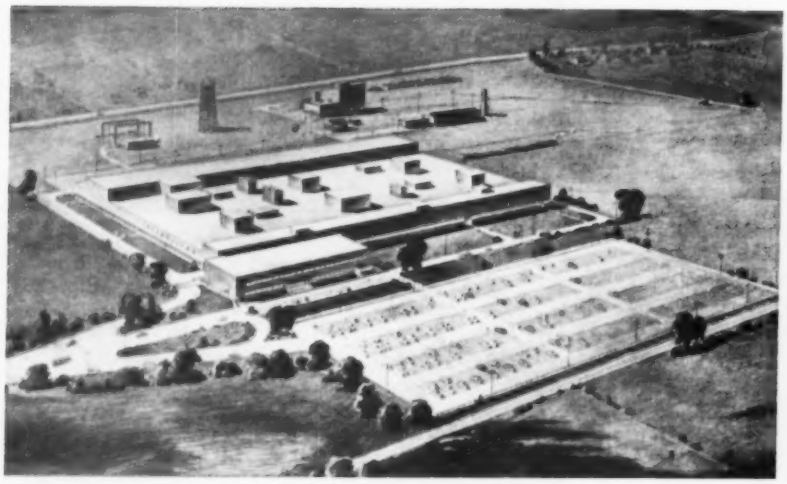


TWO WICKES STEAM GENERATORS will help heat the CATERPILLAR TRACTOR CO.'s new plant at York, Pa.



CONTRACTORS: Consolidated Engineering Company Inc., Baltimore, Md.
CONSULTING ENGINEERS: Whitman, Requardt & Associates, Baltimore, Md.

145

The Caterpillar Tractor Co., one of the world's largest manufacturers of earth moving equipment, will shortly open their new York, Pa. plant where several hundred men will turn out track assemblies for world famous Caterpillar D6, D7 and D8 Tractors. In this modern manufacturing facility, Caterpillar has installed two 80,000 lb. WICKES steam generators to obtain efficient, economical heat throughout the 360,000 sq. ft. structure. These Type R 2-drum WICKES boilers have a design pressure of 200 psi. and are equipped with economizers and spreader stokers. WICKES can fill your requirements for steam generators up to 250,000 lbs. per hour and 1000 psi. – all types of multiple drum boilers, adaptable to any standard method of firing: oil, gas, underfeed or spreader stoker. Consult your nearest WICKES representative or write us today for descriptive literature.

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typical applications and lists sizes and part numbers. Also describes mechanical pressure seals for rotary shafts. The Garlock Packing Co.

294 Manual on Packings — Containing 84 pp of engineering and ordering information, Catalog 40 covers packings for practically every service. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

295 Packings for the Power Plant — Designed as a quick-reference aid, one feature of this compact 6-pp guide is a flow sheet of a rudimentary industrial power plant with each unit keyed to the proper packings and gaskets. Illustrated. Includes construction information, sizes. Johns-Manville.

OTHER EQUIPMENT

296 Chemical Cleaning Service — Reduced maintenance costs and outage time are among advantages of company's chemical cleaning service for steam equipment and water lines discussed in this 8-pp bulletin. Before-and-after photos show some actual cleaning jobs and several case histories are given. Company's service procedure, facilities outlined. Dowell Inc.

297 The ABC of CO_2 — An interesting text covering role of carbon dioxide in combustion efficiency, 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion and tells how to determine percentage of CO_2 in flue gases. CO_2 as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. The Hays Corp.

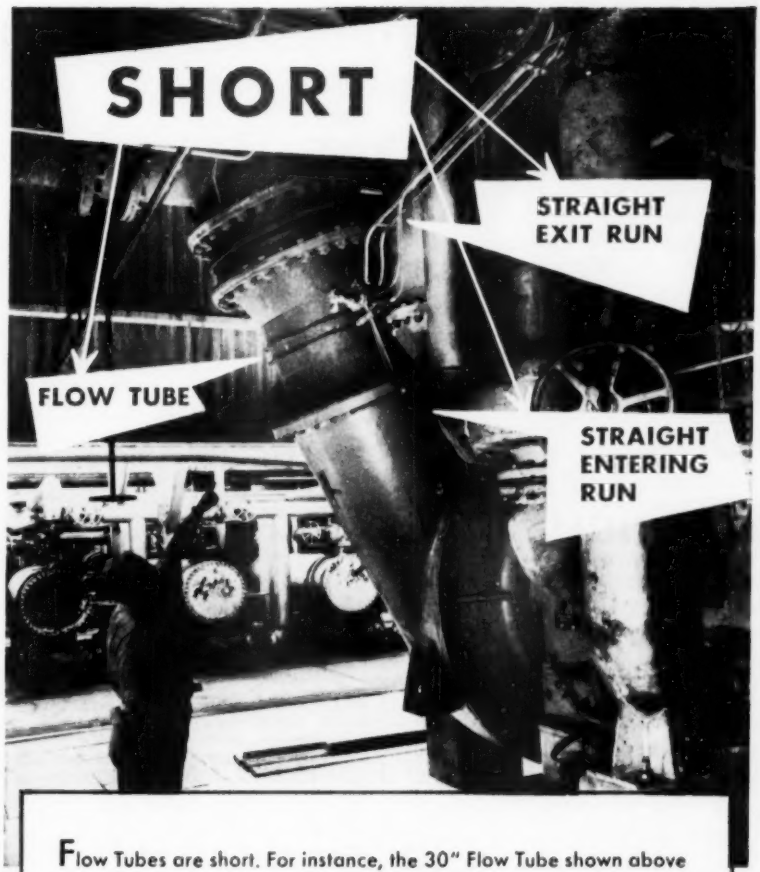
298 Turbine Generators — Bulletin H-18, 40 pp, covers turbine-generators of 500 kw and above, pictures nearly 50 turbine-generator installations, both utility and industrial. Brief discussions of generator and exciter cooling methods are included. A reference section offers detailed drawings showing a typical installation arrangement. Elliott Co.

299 Mechanical Draft Fans — Mechanical draft fans for both forced and induced draft service are described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, includes performance curves showing efficiencies of various types of fans. The Green Fuel Economizer Co., Inc.

Postage-free cards for ordering catalogs and bulletins are provided on pages 38 and 132

300 Dowtherm Vaporizer — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer, tells how this unit is designed to evaporate Dowtherm to provide dependable operation at maximum temperatures. The Wickes Boiler Co.

301 Ejector Instruction Manual — Bulletin J-50-7 is a 36-pp handbook covering operation, selection, installation and maintenance of steam jet air ejectors. Dis-



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cusses twin and triple element ejectors, surface and jet inter- and after-condensers, isolating valves, drain traps, steam and back pressures, steam nozzles. Foster Wheeler Corp.

302 Air Preheaters — Illustrated Bulletin A-11610, 8 pp, defines air preheat and explains its benefits in terms of increased efficiency and capacity and flame stability. Provides general description of company's Ljungstrom preheater. The Air Preheater Corp.

303 Motorized Chimney Draft — The advantages of mechanical draft in supplying positive, uniform, adequate draft, regardless of variable weather conditions or inadequate chimney or breeching construction are shown in detail in Bulletin I-52. Also discusses other advantages, including eliminating need for tall stacks. L. J. Wing Mfg. Co.

304 Equipment For Buildings and Institutions — Bulletin WP-1099-B27M is a 20-pp revised booklet of condensed information on sizes, dimensions, capacities, ratings and features, of a wide range of equipment. Covers air conditioning and refrigeration products, with auxiliaries: oil, gas and dual fuel engines, deaerators and deaerating heaters; water conditionings; steam turbines and turbine generators; liquid meters; centrifugal and other pumps. Worthington Corp.

305 Why Fully Crowned Teeth — Seven major engineering advantages of fully crowned teeth in gear type flexible couplings, are described in Bulletin 1052. Applications of Amerigear couplings for the solution of power transmission problems such as excessive offset or angular misalignment and space limitations described. American Flexible Coupling Co.

306 Maintenance Manual — **"Over the Rough Spots"** is a 48-pp pocket size booklet giving the answer to practically every repair or building maintenance problem. Tells how to patch holes and resurface floors, prevent water seepage in underground foundations, repair leaky roofs, preserve concrete or wood surfaces, protest structural steel from rusting, and gives many time and saving methods in solving maintenance problems. Stonhard Co.

307 Flanges for Severe Service — This 4-pp bulletin describes a flange specially developed for services involving severe abrasion and corrosives, and for suction and discharge service. Goodall Rubber Co.

308 Soot Blowers on the Job — Bulletin 1004, 32 pp, discusses 15 central station installations of Vulcan automatic-sequential soot blower systems. Power and reheat boilers with capacities to 1,370,000 lb per hour, pressures to 1925 psi and temperatures to 1055 F are included. Copes-Vulcan Div., Continental Foundry & Machine Co.

The postage-free cards on pages 66 and 132 may also be used to ask for information on advertised products. Just circle the number appearing below or above the ad

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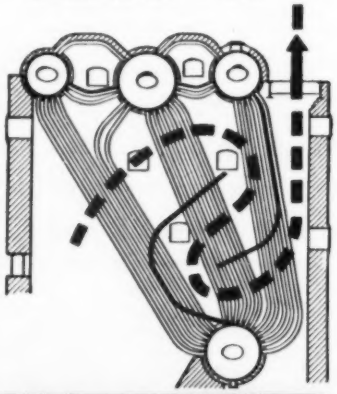

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Reducing Condensate Corrosion

Failures from condensate corrosion are sufficient in number to warrant looking into them with the object of reducing their effect. Not all condensate, however, is corrosive, but steam condensate contaminated with relatively large quantities of gases such as carbon dioxide and ammonia is corrosive to brass.

Condensate Grooving and Pitting

The condensation of water vapor on a metal surface leads to the formation of droplets of water as illustrated in Figure 1. Under most conditions when the steam is clean, droplets form, grow and roll off the tube without producing any noticeable amount of corrosion. However, if steam condensate is contaminated with gases such as carbon dioxide and oxygen, corrosion grooving may take place. Since the

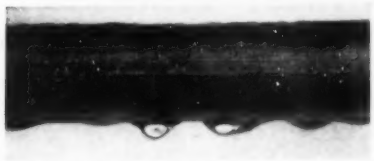

Fig. 1—Condensate cooling on cold tube.

flow of condensate is generally concentrated at the tube sheets and baffles, the deepest corrosion grooving occurs at these points. (See Figs. 3 and 4.)

Where the water droplet has absorbed small amounts of corrosive hydrochloric acid, ammonium hydroxide, etc., it may lead to the formation of deep corrosion grooves on the outside of the tubes as illustrated in Figure 2. Grooves occur where the droplets of condensate form rapidly

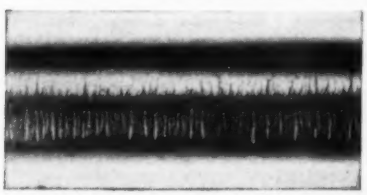

Fig. 2—Corrosion grooves produced on the surface of the tube by corrosive condensate.

at the same spot and roll down the same area on the tube surface. This may also take place where two immiscible substances condense side by side

Fig. 3—Admiralty condenser tube attacked by condensate corrosion near the tube sheet.

such as chlorinated organic compounds and water (carbon tetrachloride, trichloroethylene, etc.)

Sometimes considerable longitudinal grooving or pitting may occur on the under side of the tube where the droplets of corrosive liquid collect and hang on for some time before falling off. This also explains why considerably more thinning of the tube wall often occurs on the under side as compared with the top side. An acid condensate flowing down the side of the tube may in time also produce long deep corrosion grooves.

Reducing Condensate Grooving and Pitting

The concentration of corrosive gases in steam can often be reduced by effective venting of the unit. Sometimes it is necessary to use an ejector system for this purpose.

Fig. 4—Showing extent of corrosion grooving in arsenical copper tubing after three years' service in a vent condenser (horizontal tube) handling vapors from a boiler feedwater deaerating heater.

Where it is not feasible to remove most of the corrosive gases from the condensate or prevent their entry into the heat exchanger, it may be necessary to neutralize the corrosive gas by chemical treatment such as the injection of small amounts of ammonia or caustic soda to neutralize hydrogen chloride, organic acids, etc., used in the petroleum industry or select a tube alloy or duplex tube which will best resist the corrosive gases involved.

Ammonia May Contribute to Stress Corrosion Cracking

If the steam contains ammonia gas, the condensate will also carry some ammonia which is one of the contributing factors which may cause stress corrosion cracking. The other factors are stresses in the tubes which may be residual or applied; and the composition of the tube alloy.

Tubes as supplied to A.S.T.M. specifications and properly handled are free from residual stresses. However, they may develop applied stresses because of high operating pressures; restraint of thermal expansion and contraction; or because of residual stresses developed by rough handling such as bending, denting or flattening.

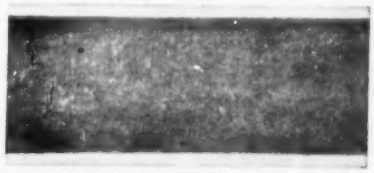

Fig. 5—Aluminum brass condenser tube which failed from stress corrosion cracking due to presence of ammonia in the steam condensate.

The resistance to stress corrosion or season cracking of copper-base alloys is influenced by their composition. Alloys with higher copper content resist cracking better than low copper alloys. The cupro nickel alloys are not subject to stress corrosion cracking under conditions which are detrimental to yellow brass. They should be specified for conditions where it is not feasible to remove ammonia from the condensate.

If your condenser or heat exchanger tubes are not standing up as long as they should, the Bridgeport Corrosion Laboratory will be glad to help you with your metal problems. Please contact the nearest Bridgeport district office for your condenser and heat exchanger tube requirements. (9613)

For more data circle 591 on Post Card

Quick Starting of Large HP, HT Boilers

(*Continued from page 101*)

The latter was investigated during some of the test starts using approximate operating measurements. Fuel saving amounts to 27 per cent at East River Station which has condensing units, and to an average of 43 per cent for the other three topping installations. The table shows these savings in detail.

To this could be added savings in auxiliary power consumption and a certain amount of labor. These thermal data may be helpful in future considerations in determining when it is economical to remove such units from service as compared to running them through week-ends at light loads; and also to boiler manufacturers as design data for rates of fuel burning required for quick starting.

Turbine Operation

Turbine procedure accompanying quick starting of high-pressure unit boilers from a cold condition does not introduce any new operational problem except that it requires shorter rolling periods.[3]

Duration of the rolling period is primarily determined by: (a) temperature, at the time of start, of the section of the turbine which is hottest under full load — generally the steam chest when it is integral with the turbine shell — and (b) design of the turbine shell. Single shell construction requires a longer warming period than double shell construction, everything else being equal. The rolling period of double shell turbines does not need to exceed 30 min when the initial shell temperature is between 250 and 300 F.

Single shell turbines, because of their massive horizontal flange design, require more time. However, the critical period occurs mainly after the unit is on the line and while being loaded, irrespective of time taken for the start.

Conclusion

The basic objective of starting 1,000,000 lb per hr, high-pressure, high-temperature boilers from a cold to a steam condition for turbine synchronization in 1 hr has been successfully accomplished without any shortening of normally expected superheater tube life, and with drum tangential and radial stresses less, except at drum ends. In these areas where stresses are higher during the short start, minor drum internal baffle changes can be made which could reduce these stresses considerably below Code allowable values.

One-hour starting time — while apparently not the minimum possible starting time — is a reasonable time to permit a complete check by operators of boiler and turbine conditions during the starting period.

Data of these tests may prove useful to other utility operators, when their system growth and number of installations of high-pressure, high-temperature units reach a point where week-end shutdowns become necessary; and to boiler designers for consideration of provisions in current and future designs for improved circulation in drum ends, and to permit them to issue more definite recommendations to operators in regard to permissible drum metal temperature spreads at the various drum pressures during the starting period.

Meanwhile, testing during quick starts-from-cold will continue.

1953 National Electronics Conference to be in Chicago

NATIONAL ELECTRONICS CONFERENCE INC., 1953, will be held September 28, 29 and 30, 1953 at the Hotel Sherman in Chicago. Dr. J. D. Ryder, head of the electrical engineering department, University of Illinois, Urbana has been named president. Dr. C. E. Barthel, Jr., Illinois Institute of Technology, Chicago has been named chairman of the board. Additional information can be obtained from S. R. Collis, Chairman, N.E.C. Publicity Committee, Illinois Bell Telephone Co., 208 W. Washington St., Chicago 6, Illinois.

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HALL INDUSTRIAL WATER REPORT

Hall Laboratories, Inc.—A Subsidiary of Hagan Corporation, Pittsburgh, Pa.

Volume 1 | APRIL 1953 | Number 2

Water as a Raw Material

The sea is a vast storage bin of elements necessary for 20th century industry. Extraction of elements requires the handling of tremendous quantities of water; 300,000 gallons of water to get a ton of magnesium, 5 million gallons for a ton of bromine.

Water is necessary to all industry, where it is used as a solvent, a carrier, a diluting element, dispersing and cooling agent, for cleansing. Water is your industry's most important raw material—don't waste it!

From British West Indies To Japan, Hall System* Goes International

Alex Henricks, engineer on the Hall headquarters staff, by-passed three weeks of U.S. winter weather in the British West Indies, where he initiated Hall System* in a sugar factory boiler house. This plant had asked advice of a local company (a Hall client) after suffering tube losses due to corrosion.

And Hall "know-how" in industrial water conditioning is now being exported to the Orient. Japan Organo, Ltd., representing Hall Laboratories, is introducing Hall System* and applying Threshold Treatment with Calgon* to cooling water as well as to various process industries. To accomplish this, Mr. Tadashi Nagao, chemist for 20 years with a Manchurian utility, recently spent 6 weeks at Hall headquarters.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire, or call Hall Laboratories, Inc., P. O. Box 1346, Pittsburgh 30, Pennsylvania.

SLUDGE-STALLED BOILERS BACK ON THE LINE

Sometimes it's just plain sludge, but the unusual keeps Hall engineers hunting for process leaks

In one specific case, use of only 30 per cent of unsoftened make-up caused sticky sludge accumulation in tubes, and so deep in the drum that the feed pipe was almost covered. A quick analysis of this sludge by Hall Laboratories identified it as calcium phosphate, magnesium silicate, and magnesium phosphate.

Burosil* fed to the boiler precipitated the magnesium as magnesium silicate. Now boilers are virtually sludge-free, and operate through the entire heating season, instead of having to be cleaned at 2-month intervals, as formerly.

That was a normal problem. But the boiler water of a ceramic plant contained a lot more suspended matter than should have been there. A check on the feedwater by the Hall engineer showed why—it was carrying clay "slip."

When a break in the condensate line was located and repaired, no more "slip" was pulled into the system by the vacuum return system, and boiler operation returned to normal.

Once in a while, the Hall men run onto a corker. Like the boiler sludge that developed in a plant which makes certain catalysts. A sudden drop in boiler water alkalinity heralded the trouble. Make-up water composition had not changed, but inspection revealed an exceptionally heavy sludge. Analysis of the boiler water showed 5 times the normal dissolved silica concentration. Suspended solids showed high silica and alumina. Guided by these clues, the operators and Hall men traced the trouble to one of the process heat exchangers. Several leaky tubes were found which contaminated the condensate returns with catalyst.

It sounds easier, in capsule form, than it really was; however, the sludge problems were handled quickly, because in each case, facts developed at Hall Laboratories pointed a way to the solution.

Equipment for Water Analysis Shown to Pittsburgh Conference

In early March, Hagan Corporation exhibited apparatus, developed by Hall Laboratories for use in water analysis, to the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy. Electrical conductivity equipment, cooling coils, and the Hagan Automatic Degasser for securing gas-free samples of condensed steam were shown.

Hall Certified Reagents were featured together with associated equipment for running Schwarzenbach hardness titrations, a new rapid anion exchange method for solids in boiler water, and other selected colorimetric and titration procedures.

*"Calgon" and "Burosil" are registered trademarks. "Hall System" is registered as a service mark by Hall Laboratories.

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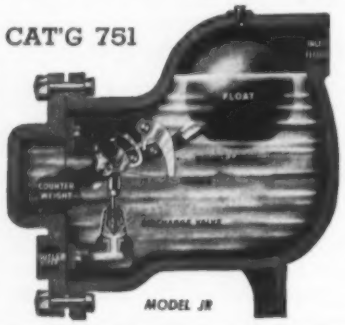
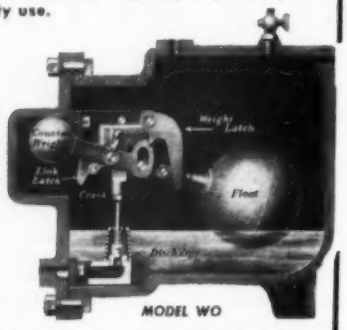
NEVER NEED PRIME

Nicholson weight-operated traps, under no condition, leak live steam. This prevents the costly loss of steam occurring when bucket traps lose their prime as a result of drying up in superheat or flashing at sudden pressure drops. Under these conditions Nicholson weight-operated traps still hold tight because they do not depend on buoyancy of float to raise valve. Widely used for steam purifiers, super-heated lines, headers, separators, heaters, dry kilns, pipe coils, turbine throttle valve drips, stop and check valves, etc. Also for air and gasoline. Furnished in 3 Types—pressure to 200, 500 and 1500 lbs.; for every large-capacity, heavy-duty use.

CAT'G 751





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New ENGINEERING BOOKS

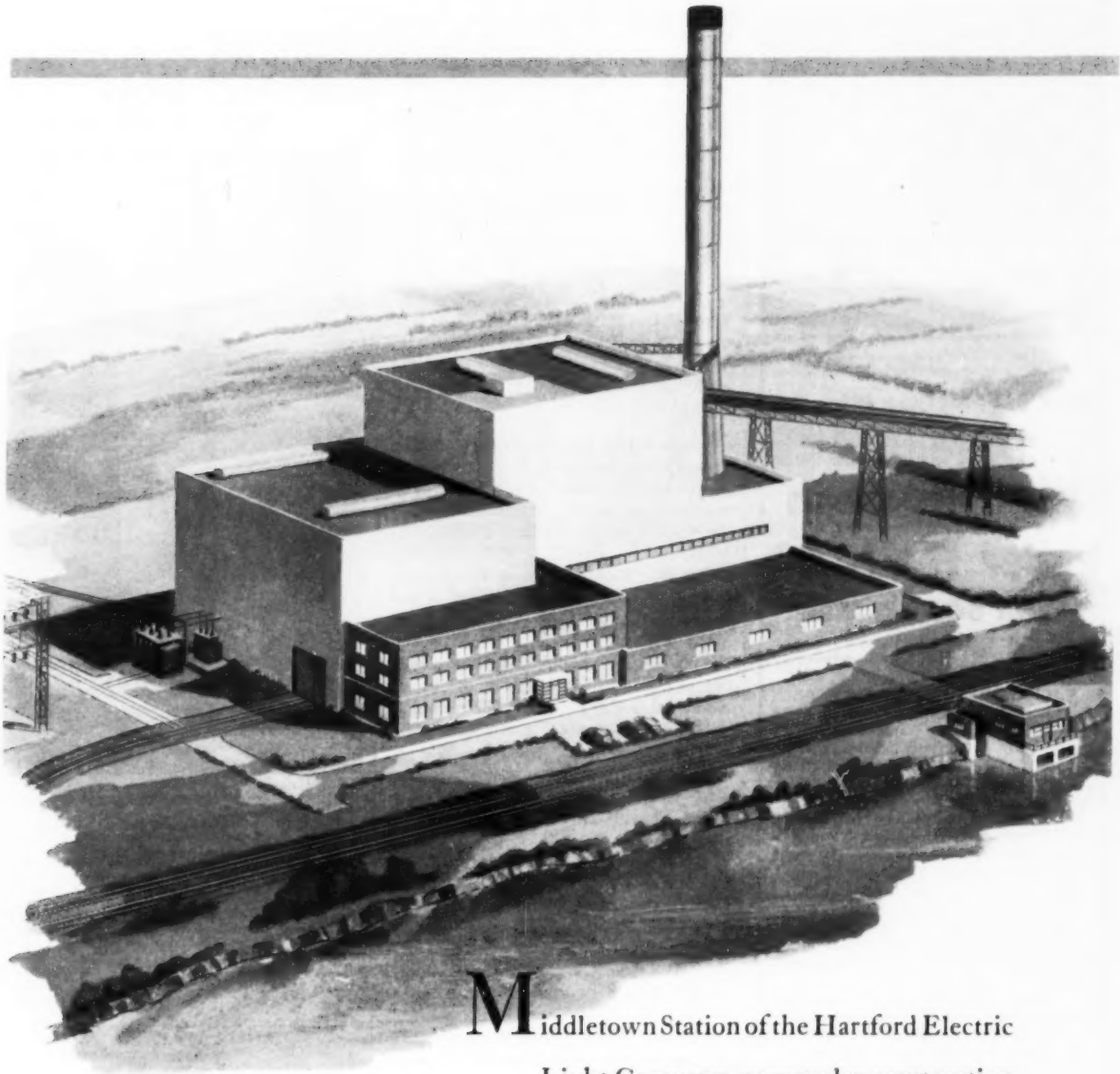
Elementary Heat Power, by Harry L. Solberg, Orville C. Cromer and Albert R. Spalding; Second Edition; 624 pages; 6 by 8¾ in.; illustrated; cloth; published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y.; 1952. Price $6.50.

This very good book on heat power is the result of a chain of forces set in motion by educational needs during World War II when it became necessary to transfer all civilian engineering students at Purdue University to the curricula of the Navy V–12 Program. This made it desirable to critically evaluate the pre-war curricula in Mechanical Engineering and to develop a post-war curriculum that would give a great deal of attention to the heat power sequence of courses. These studies resulted in the publication of the First Edition of this book in October 1946.

It was prepared to be used as a text in a first course in heat power, preceding a thorough course in engineering thermodynamics, or in a terminal course for non-mechanical engineering students. The book, however, will also be useful to those who, after several years of experience in the various fields of heat power, wish to arrive at a better understanding of the principles behind the equipment they operate.

The ideas behind this book can be grouped into three divisions: First, to develop an understanding of the function, principles of construction, and actual performance of heat power machinery so that the student will appreciate the importance of and may intelligently study and apply the principles of engineering thermodynamics; second, to provide an adequate and balanced terminal course for those students who do not study engineering thermodynamics; third, to provide a background for the testing of heat-power equipment in the laboratory.

The Second Edition of the book represents the seasoned judgment of the authors, based on their own experience and the experience of using the earlier edition and in teaching subsequent courses in thermodynamics. This Second Edition has been expanded by about 100 pages, principally to permit the discussion of the general energy equation of the steady flow process as the first law of thermodynamics, and its application to power plant equipment, and to include a fairly complete discussion of engineering units and dimensions. A separate article has been added to summarize basic concepts and definitions. Entropy has been introduced as a property that is constant during an ideal expansion. The Mollier Diagrams for steam and ammonia and an abridged table of the thermodynamic properties of air have been included to facilitate computations and familiarize students with these aids to the solution of problems.



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All the authors are on the staff at Purdue University. Harry Solberg is Head of the School of Mechanical Engineering; Orville C. Cromer is Associate Professor of Mechanical Engineering; and Albert R. Spalding is also an Associate Professor of Mechanical Engineering. Their manifold experience has enabled them to write a book that is not only extremely useful as a textbook, but also to those in the field who wish from time to time to refresh themselves on the underlying concepts of heat engineering.

* * *

White Collar, by C. Wright Mills. First Edition; 378 pages; size 5½ x 8½ in.; cloth; published by Oxford University Press, 114 Fifth Ave., New York 11, N. Y.; 1951. Price $5.00.

To this writer, here is a most discouraging book. Every engineer, or nearly every engineer — and especially power engineers — ought to read it. For they are members of the white collar or middle class that Mr. Mills is writing about.

But it is doubtful if more than a mere handful of engineers ever will read it and that is why the book is so discouraging.

It is discouraging because its fundamental thesis is that the middle class in this country, one of the last middle class groups in the world, has neither the ability nor the will to do the things that will get it out of the squeeze it is in.

There is no question that the white collar class — engineers, managers, teachers, secretaries, sales girls, lawyers and so on — is in a squeeze in this country.

Unfortunately, Mr. Mills does not provide the answer; but he does graphically describe the situation of white collar people today. He shows first the transformation of property, then discusses the competitive system, then the new middle class. He then attempts to analyze what brains are worth today, what is the function of the salesman. He discusses what is meant by white-collar prestige and the general status of the white collar man in the big city and the small city. He discusses the common white collar conceptions of success and ends by covering in detail the various organizations and social and political groups through which some white collar people hope to solve their problems.

The book is a powerful and interesting portrayal of an important bracket of American society because, in spite of all the white collar man's problems, it is he (and she) who is central "to the tang and feel of life in this country".

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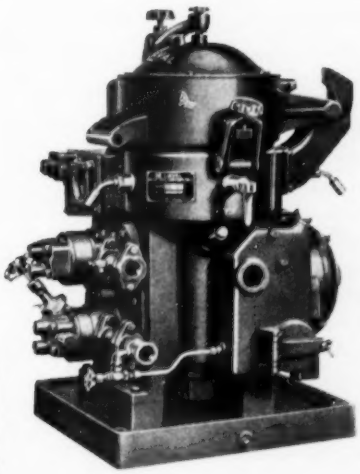

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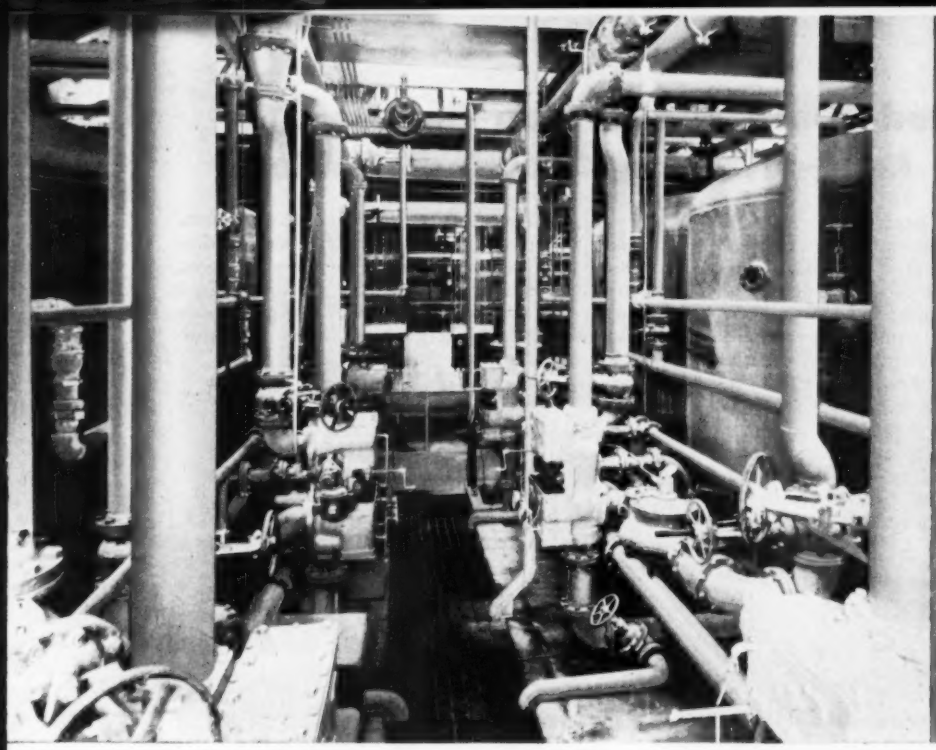

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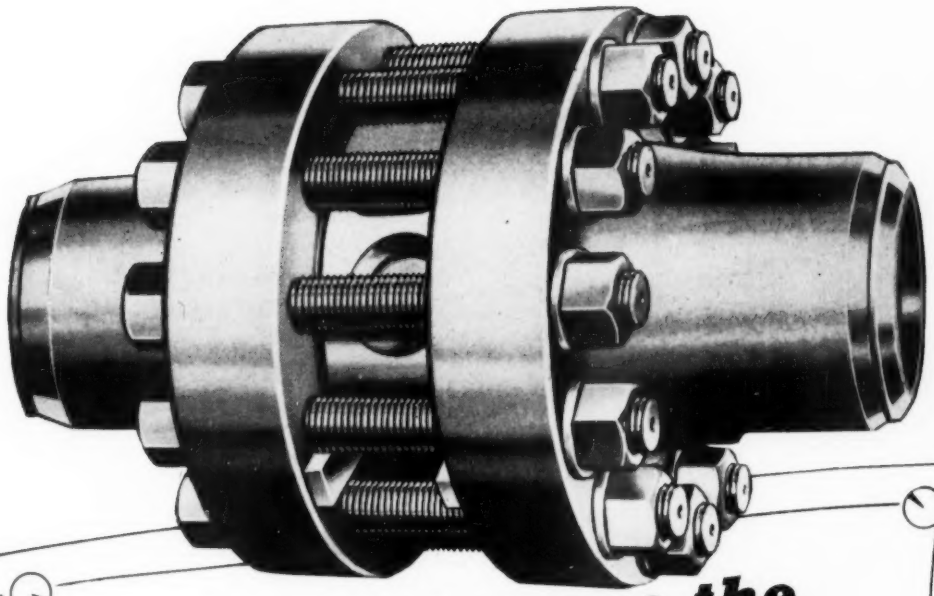

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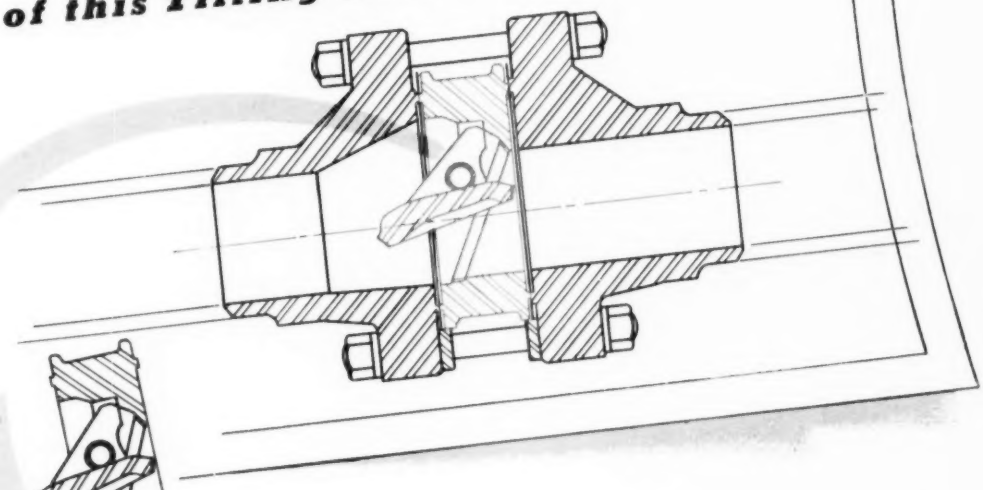

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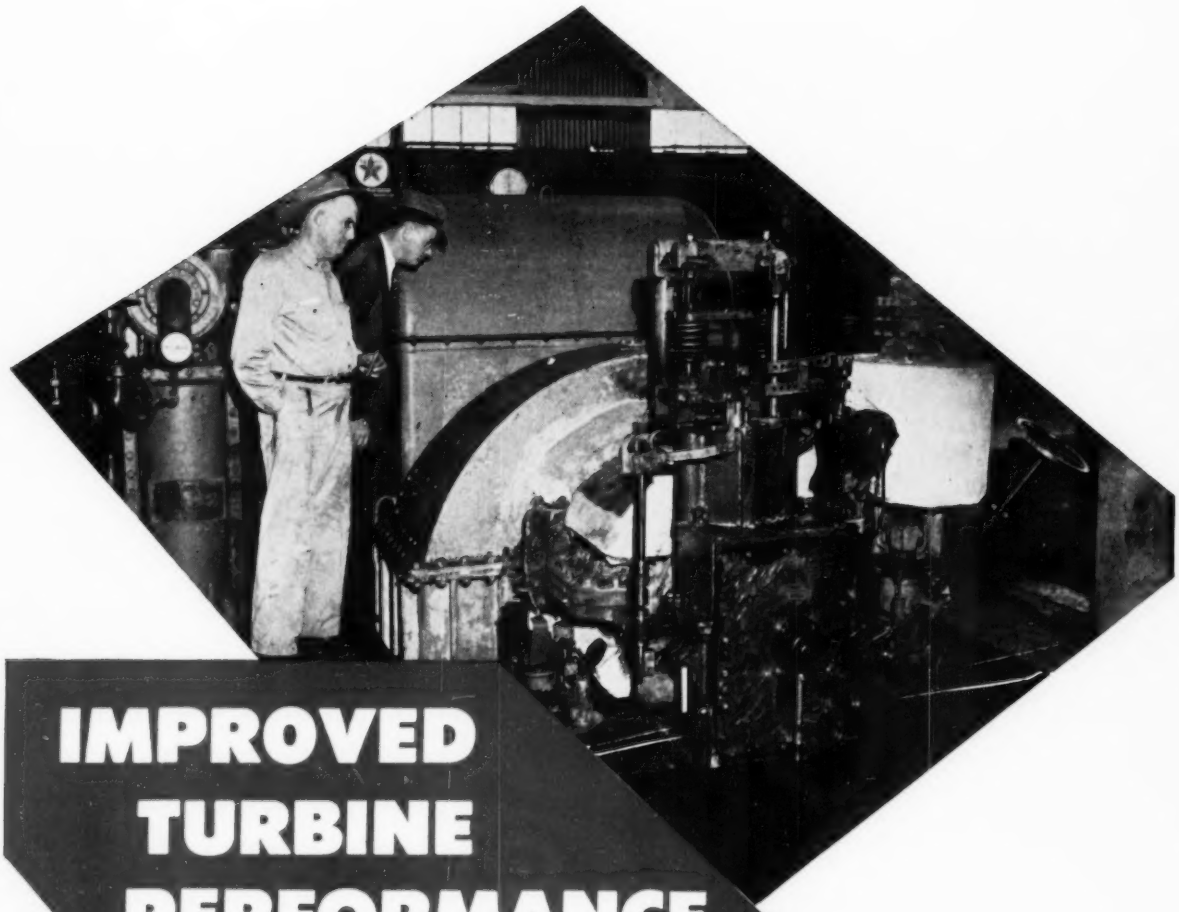

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